SCIENTIFIC AMERICAN

The Monthly Journal of Practical Information

35¢ a Copy NOVEMBER 1921 $4.00 a Year

THE STEADY HAND AND THE WATCHFUL EYE: IN THE CAB OF AN ELECTRIC LOCOMOTIVE

Scientific American Publishing Co., Munn & Co., New York

THE SCIENTIFIC AMERICAN, November, 1921. Volume 125-A, Number 17. Published monthly by Scientific American Publishing Company at 233 Broadway, New York, N. Y. Subscription price, $4.00 per year. Entered as second-class matter June 18, 1879, at the post office at New York, N. Y., under the act of March 3, 1879.

With the Editors

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HERE is the initial issue of the new monthly SCIENTIFIC AMERICAN—a combination of the former weekly SCIENTIFIC AMERICAN and the SCIENTIFIC AMERICAN MONTHLY. Considering the strenuous conditions under which we labored in getting this number together, we are rather pleased with our product, especially now that we can turn over the page proofs and visualize what the finished copy will be like. Please pardon our seeming self-praise, but here is what had to be done: First of all, the regular weekly SCIENTIFIC AMERICAN had to be continued week by week up to the issue of October 15th. Secondly, we had to turn out the former SCIENTIFIC AMERICAN MONTHLY, with all its mass of original and abstracted material, up till the October issue. Thirdly, we had to strain every resource at our command in order to gather the best material possible for this November issue. Three periodicals under way at the same time—twice our normal work! However, if you are pleased with the product, we are amply repaid. Now, with the two former periodicals combined into a single journal, we can concentrate every effort on the big December issue, which will be in your hands by November 20th.

SOME weeks ago Hudson Maxim, the distinguished inventor, drove us out to the Edison laboratory in company with Garrett P. Serviss, the scientific lecturer and writer. Mr. Maxim had arranged the gathering, we suspect, with the intent of provoking a discussion of the Einstein theories, which at the moment were in the front of his mind. He generally has his way when it comes to determining the subject of conversation, but this occasion was an exception. Mr. Edison had something in the front of *his* mind—the questionaire which he had just devised for applicants for employment, and which was just at a point where its successful working was assured. So Mr. Edison, with a little assistance from the rest of the gathering, talked questionaires all the afternoon. This particular affair was not an interview, since Mr. Edison was not at the time ready to talk for publication, but it put us on the trail of the story. We have since then had three further talks with Mr. Edison and have been allowed to examine a number of the papers written by his candidates. The result is the story that appears on page 16. We know you will find it amusing in spots; we hope you will find it instructive and timely as well.

EDITORIAL work, after all is said and done, is not a great deal different from running a store. It is the editor's part to size up his readers and determine what they want, following which he secures the right kind of material and presents it in the most attractive manner. Carrying our comparison just a point further, we cannot but feel that there is a great deal of wisdom in that store sign which says: "If you don't see what you want, ask for it." Why not use the same sign in editorial work? Much as we endeavor to keep in close touch with the wishes of our readers, there are times when even the closest contact fails to bring any request for very much desired information or editorial comment on some specific subject. Why not, then, "ask for it?"

HERE is a little incident which took place "behind the scenes," so to speak, a few weeks ago. A member of our staff, who, over a year ago, wrote about the remarkable Belin system of transmitting photographs, drawings, type matter and other images over wires, received the following telegram: *"Serons reconnaissants bien rouloir nous fair expedier extreme urgence Belmont Hotel Bar Harbor, Maine transfermateur genre telephone rapport transfermation un a quinze environ remerciments. Belin."* Translated, this says: "Would appreciate if you would be good enough to ship us in extreme haste, to Belmont Hotel, Bar Harbor, Maine, a telephone type transformer with transforming ratio of about one to fifteen. Thanks. Belin." We did—the following morning. Frankly, we are pleased to play a rôle in such momentous undertakings as the transmission of facsimile messages via radio across the Atlantic. Mr. Belin recently came here again from France in order to receive drawings, cartoons, facsimile messages and other images at Bar Harbor, Maine, from the Lafayette radio station at Bordeaux. Of course, we shall get the first complete and authentic data regarding Mr. Belin's remarkable experiments—perhaps in time for the December issue.

WE are in good company in this November issue. Such names as Lindenthal, Simon, Hornaday, Russell and Steinmetz mean a great deal in their respective fields—bridge building, medicine and municipal administration, natural history, astronomy and electrical engineering. We have been most fortunate in securing articles from the pens—or typewriters—of these well-known men. Then there are others represented in this issue, even though their thoughts and plans and views are reported by our editorial staff and regular contributors. Thus we have Edison's comments on his questionaire; Small, Vice-President of the Underwriters Laboratories, on airplane fatalities and risks; Murray, on his super-power zone; and so on. Already we have an imposing list of leaders for the December issue; indeed, every issue of the new monthly SCIENTIFIC AMERICAN must and will be a platform, so to speak, from which leaders in all fields of technology can address the laity, either in person or through one of our staff writers.

FAMILIAR enough is the sage advice, "If you want a thing well done, do it yourself." Of equal standing is the maxim, "Don't write; send." Perhaps the ideas back of these two old saws might be combined into a "new saw," if there be such a thing: "If you want to know, go and see." We did want to know something about the condition and the relative merits of the several avenues of automobile communication between east and west; we did want to sort out the conflicting testimony about them. So one of us volunteered to combine business with pleasure, to the extent of spending his vacation in his "flivver." We think his report of what he found makes mighty interesting reading. You will find it on page 6.

ONE of the novel features of this new form of ours is the almost total freedom from the objectionable line, "Continued on page ——." Most of our readers will recognize in the freedom with which we now run our articles on to a second or even a third page, the means of avoiding this turn-over expedient. Were the SCIENTIFIC AMERICAN just a monthly periodical and nothing more, such turn-overs would matter but little; but, as we learn from a mass of correspondence on this subject in past years, this journal is regarded as a permanent encyclopedia or reference work. Many of the articles in its columns are carefully clipped and filed away for future use. And the simpler we make that task, the more serviceable becomes our work for a vast host of readers.

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Vol. 125-A, No. 17. Published monthly. Entered as second class matter, June 18, 1879, at the post office at New York, N. Y., under the Act of March 3, 1879.

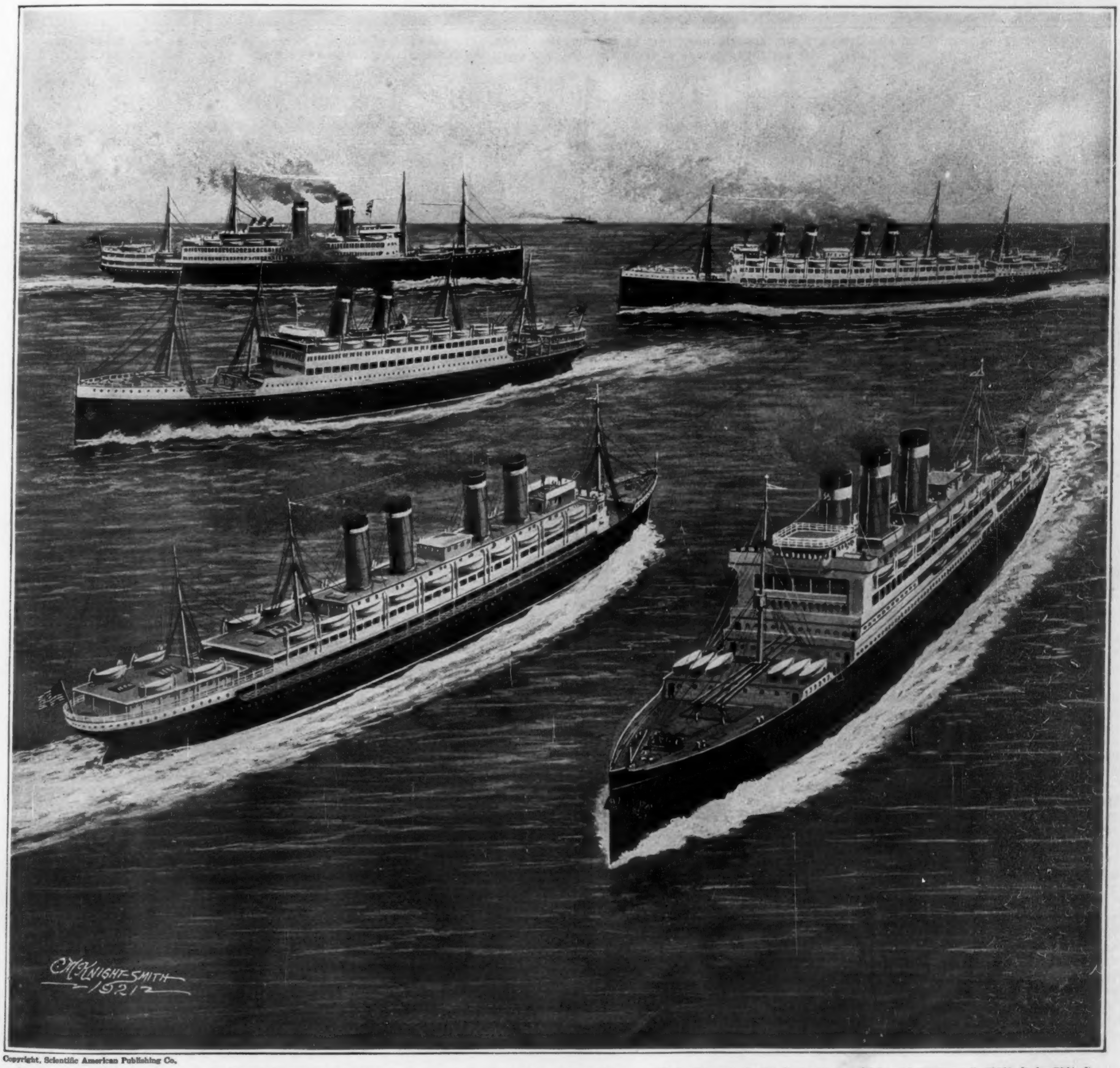
Price, 35 cents a copy. $4.00 a year. Postage prepaid in United States and possessions, and Mexico, Cuba and Panama; $4.50 a year for Canada. Foreign subscriptions, $5.00 a year, postage prepaid.

SEVENTY-SEVENTH YEAR

SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, NOVEMBER, 1921



The five great passenger ships of the United States Shipping Board, shown above, reading from the top down are—*Left:* "America", 669 ft. by 74 ft. *Right:* "Agamemnon", 684⅓ ft. by 72⅙ ft. *Left:* "George Washington", 699 ft. by 78 ft. *Left:* "Mount Vernon", 685⅓ ft. by 72⅓ ft. *Right:* "Leviathan", 927½ ft. by 100 ft.

"The Big Five" of the United States Shipping Board—(See page 9)

View on the new Federal Road into Austin, Nev., through forest reserve and desert country. The old trail, of which a piece is visible in the gully below the new embankment, had continuous grades of ten and twelve per cent; the maximum on the new is six per cent

Tours and Detours

Impressions of the Through Automobile Highways of the Eastern and Central States

By J. Malcolm Bird

THE last word with regard to ultimate acceptability lies with the ultimate consumer. Our roads just as truly as anything else are an article of manufacture and use; the ultimate consumer is the man who uses them—driver of car, of truck, in less degree of horse. Road building and maintenance, dead from 1917 to 1919, revived in 1920 and regained their health in 1921. During the past summer I have played the part of ultimate consumer over many roads, including some 2,000 miles of our main intersectional highways. In view of the prospect that 1922 will see even greater road activity than the past season, I venture to set down here my impressions, in the hope that some of them at least will fall on ground not barren.

The outstanding feature of the present condition of our roads is the contrast between town and country. Over the entire length of the Mohawk Trail and less consistently on other routes, city lines are marked by signs informing the motorist that he is entering the corporate limits, that here state supervision of the road ceases. As a study in cause and effect these boards are admirable; as bearers of information they are superfluous. You drive for miles through open country over a velvet highway. Suddenly you are jounced and jerked over a dilapidated brick pavement, or pitched into and out of deep holes in prehistoric macadam, or made to vibrate to the alternate sharps and flats of a "block" pavement of which no two adjacent blocks by any chance strike the same level. No sign is needed to identify this as the city.

The reasons for the condition are obvious enough. Perhaps the road is occupied by a traction line, bound by franchise to keep the street in order. The natural disinclination to smooth the way for automotive competition is bolstered by the fact that the plea of semi-bankruptcy is uncomfortably close to the truth. And in the absence of a trolley company to act the villain, the city fathers, before appropriating $100,000 for two miles of modern concrete on Main Street, demand to be shown just how and when and whence the money is coming back.

There are two angles to this situation. On one of them no sympathy is due the local obstructionists. If the merchants of a 20,000 town insist that a main street resembling in general contour the devastated regions of France is good enough for them, they are probably right. For people who are satisfied with that kind of a street, that kind of a street is the most fitting reward I can imagine.

The local viewpoint, however, is not entirely wrong. It is not true that nobody from out of town has to use the street if he doesn't want to. In these days of broad interdependence, no community can withdraw into its shell and thus divorce itself from playing its part in the world's business. Cars and trucks from other parts of the state and from other states *do* have to use that street. But it *is* true that in proportion to the degree of such use, the local taxpayer may reasonably demand freedom from liability for the bills—until the happy time when *every* community keeps its streets in good shape, putting the matter on a basis of perfectly even exchange.

In driving through seven states over a period of eighteen days, I saw at least twenty-eight different license plates. In one small town I counted eleven among fifty-odd cars parked about the public square. Road commissions and automobile associations try to make the local people see that the money spent by these tourists pays for their use of the streets. But it takes a lot of gas at twenty-odd cents a gallon, vast numbers of tourists supplied with bed and board, a great volume of garage service, before the profits on these enterprises will match the cost of converting Main Street into a highway for transcontinental freight and passenger traffic.

Ultimately the matter will be dealt with by mandatory legislation, which will compel the recalcitrant communities to pay their share of the cost of fixing their streets for their own and for other people's use. Until such legislation is general it must be a matter for negotiation. Even on this basis it is not hopeless, if both parties will be reasonable. Announcement was recently made that arrangements had been reached for the reconstruction of the main street of Downington, Pa., "which in the past has been one of the worst stretches on the Lincoln Highway in the state." I saw concreting in progress, in the neighboring town of Coatesville, on what must have been a close rival of Downington for the place of ultimate dishonor. When Downington is fixed up there will be only one place in the 350 miles between New Brunswick, N. J., and Uniontown, Pa., where the motorist need feel seriously put out by bad city pavement—that awful quarter-mile on the outskirts of Morrisville, Pa.

A perfectly maintained macadam section of the Lincoln Highway in Ohio

Ohio, despite the fact that I broke a spring in one of its lake-front towns, is free from serious reproach in the matter of its Main Streets. Incidentally, I derived great spiritual consolation by limping ten miles to the next town to get that spring replaced. Indiana is in even better case than Ohio, so far as I saw it, though I did not cover so large a proportion of its territory. The Mohawk Trail is the prime offender: the good pavements of Batavia and Geneva stand out as oases in the drive from Buffalo to Albany. Among the smaller cities, I give the place of honor to Van Wert, O.; not alone its pavements, but every detail of the impression it makes on the tourist, is unusually fine. Erie, Pa., seems about the best of the cities of comparable size; one who has seen it only from the train will have difficulty in reconciling the thoroughly disreputable aspect which it there presents with the fine character of its residence and business streets. The same thing is true in less measure of Syracuse. Of the first-class cities, I have no hesitation in giving ranking position to Cleveland: I drove clear through, from west to east, during the evening rush-hour, in considerably under an hour and with no bad going at all. To one accustomed to doing his city driving in New York and Newark this is a miracle.

I hope I will not be accused of sectional bias if I say a word in extenuation of Jersey City. Every motorist from out of town who has crossed any of New York's downtown ferries must have unpleasant memories of this part of his trip. But we ought to remember that with the big town just across the river, no driver is going to stop in Jersey City except in dire emergency, so that here more than anywhere else the complaint that good streets don't pay is justified. You do not have to drive through Jersey City to get to New York, however: go north from Newark, cut across through Hackensack and Englewood, and use the Dyckman Street or the Ft. Lee Ferry. (The former shuts down during the winter months.) Better yet, go north before coming to Newark, and drive along the Watchung Mountains to Montclair or Paterson, and you will learn something about New Jersey scenery that does not seem to be generally known. I don't suppose the Lincoln Highway will ever be the best way of getting from New York to the Raritan River.

After bad pavement, the motorist's outstanding dread is the detour sign. Here again I am prepared to be reasonable. Roads wear out and have to be rebuilt; new knowledge makes it desirable to put down a type of roadbed that is less amenable than the old to construction without interrupting traffic. Few roads are wide enough to permit the contractor to establish himself on one side and leave the other open, with or without a flagman according to the length of the single-track stretch. And the very fact that the road affected is the main line means that any route selected for the detour will be inferior.

All this is admitted. But during the early part of the last summer there was a detour out of Gettysburg

on the Lincoln Highway seventy miles in length, over mountain roads built for the one-horse shay and never reconstructed. I drove into Mansfield, Ohio, from the east over bad dirt roads for forty miles—parallel with the Highway all the way and never more than two or three miles from it. I encountered a similar 30-mile detour into Erie from the west. It is respectfully submitted that there never was and never will be any justification for atrocities of this sort.

There is doubtless a certain amount of convenience to contractors and county authorities in closing, once for all, the entire length of road upon which operations are to be conducted during the current season. One can even imagine circumstances under which it might be similarly convenient to carry on work at several isolated points, so distributed along the road as to close a stretch of many miles. But the convenience of county authorities and of contractors is not the only factor that ought to be considered; the convenience of those who are trying to use the roads should be weighed for what it is worth. The loss to truck and car owners through an unreasonable detour may far exceed the loss which would accrue to contractor and to the county treasury through a more rational distribution of the work. I cannot imagine conditions under which it would not be feasible to confine operations to a comparatively short stretch of the road at a time, concentrating a larger number of men on this stretch if this were desirable, so that at no time would it be necessary to close more than five or at the outside ten miles of the main road. In the presence of parallel roads—they are universally present in Ohio—this could not lead to detours of more than fifteen miles. In their absence, and under the greatest misfortune in the matter of intersecting roads, it should not in a settled country like Pennsylvania lead to a circuit of more than twenty-five miles: seldom to one so long. Incidentally, I should like to call Ohio's attention to the custom in New Jersey, where the rebuilding of a bridge is ordinarily preceded by the construction of a temporary crossing alongside the permanent site, before the old structure is demolished. This practice removes the last excuse for long detours.

A word of caution, however, may be inserted here, drawn from my observations of the detour that has existed between Trenton and Philadelphia during the past season. In this instance an effort was made to follow the procedure which I have outlined, confining the work to reasonable stretches of road at a given time and making the detour only long enough to circumnavigate the parts affected. I have been over this route several times during the past season, and have not found this detour any two times in the same place. This is fine; but it is rather discouraging to discover, after following it in its latest location for five miles, that the gentleman in charge of the relocation of the signs has got tired of his job, and after getting one nicely on to the thoroughly dilapidated-Bristol road, has left one to blunder into Philadelphia by the side door, or to wander back to the Highway at an indeterminate point, as one best could. It doesn't do to shift the detour without shifting the signs. Whatever I might have had to say about detour signs *per se* is said by a contributor on another page.

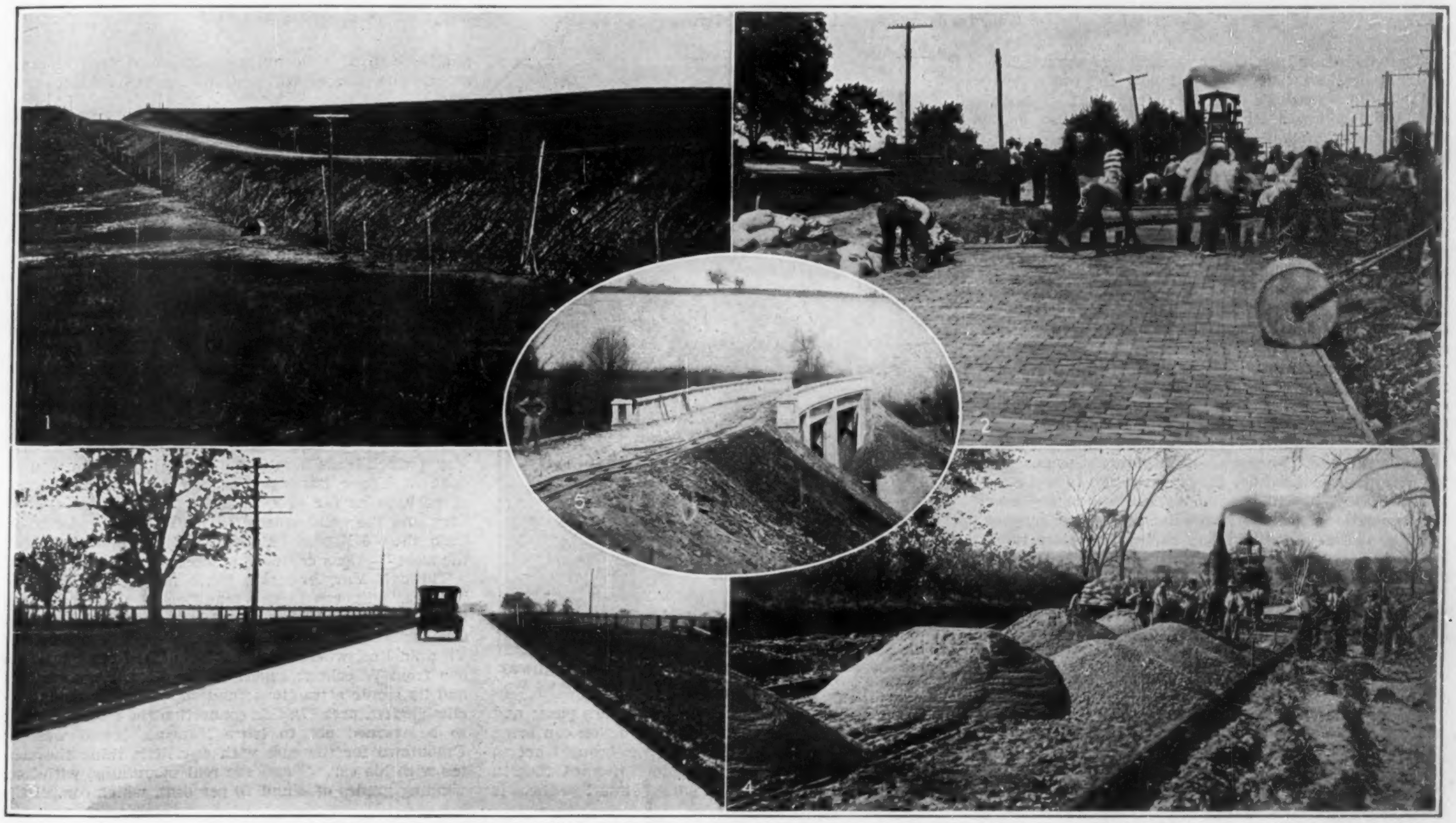
There are certain radical differences between different sections of the country which come strongly to the attention of the visiting motorist. Here in the east we do not expect our roads to be straight, just so they ultimately arrive at the point to which they are supposed to go. We run them around swamps, hills, hillocks—the most trivial of obstacles, in fact. Throughout the middle west, with trifling exceptions, the roads run straight east-west and north-south, with at most a little jog here and there to effect a more favorable crossing of a stream. This makes it impossible to get seriously lost. One has only to count the turns to be absolutely certain of one's direction. And one has but to watch the telephone wires to know whether one is approaching or receding from a town. If they thin out as you run past the widely spread houses you are leaving a town behind you. When they disappear altogether you are crossing the no-man's land between the districts served by two consecutive towns. When you finally pass a house again and begin to pick up the poles with their wires, you are certain that you are approaching civilization once more. It may not be the town you want; if it is not, the worst thing possible is that you will have to turn north or south to that town. Getting completely off one's course and at loss for one's direction or location is out of the question. But the Ohio and Indiana drivers must have a tough time till they get used to the erratic behavior of the eastern roads.

The easterner who goes through the middle west and gets off the really big routes of travel, however, has one unpleasant surprise in store for him when he asks the way. The answer will invariably be "Keep right on the Pike; don't turn off." And within the next ten miles there will be anything from five to twenty places where there is a fork, both branches of which look exactly alike to the untutored eye. The native labors in the firm conviction that the "Pike" is stone and the other roads dirt, but if there is a distinction it is not visible to the eastern eye. I suffered from this, more than anywhere else, along the Colerain Pike, which runs across the Ohio hills from Wheeling to the Canton and Cleveland district, connecting there with the Lincoln Highway. As one goes west, the rectangular system of laying down the roads of course abates this nuisance considerably. A crossroads is not half as puzzling as a fork.

Another curious departure is found in the matter of the treatment of the garage help. My eastern readers would know better than to come back to a garage where they had taken on air or water without crossing the attendant's palm with silver. They would know what reception to expect if they drove up to a strange garage and helped themselves to these commodities. In the central states you are always expected to help yourself.

The very air-stand is out on the curb, and there is no control cock that has to be opened indoors. I had to apologize to a garage hand in Wooster, O., to whom I innocently and as a matter of course offered a quarter after serving myself from his hydrant and air-stand. They do not even charge, or expect a tip, for distilled water for your battery, as I learned to my further humiliation in Mansfield. And if there is anything to be done on the internals of your car, they are glad to have you hang around and watch them take it apart, offer advice and pump them for information, help them with recalcitrant bolts or other two-man jobs, and generally conduct yourself as though you were one of the firm. The man from Ohio or Indiana will have to tour the New York district before he can realize what a jolt all this is to the easterner.

The Lincoln Highway has been advertised until the average man has the impression that with the exception of a few final touches here and there it is prac-



1. Typical fill on permanent grading in Crawford Co., Ia. 2. Laying monolithic brick east of Bucyrus, O.—work responsible for one of the detours to which the author was subjected. 3. One of the fine new stretches of concrete Lincoln Highway in Indiana. The view might equally well have been taken in eastern Pennsylvania, or between New Brunswick and Princeton, N. J. 4. Building the permanent Lincoln Way in Linn Co., Ia. 5. The old and the new of Lincoln Highway bridge construction. In addition to the obvious difference, the elevation of the new crossing eliminates heavy grades leading to the bridge at either end. Many of Ohio's streams lie in deep gullies, and are bridged at the level of the stream instead of that of the surrounding country; but new construction is gradually remedying this

Typical examples of the sort of engineering work that is going into the 1921 sections of the Lincoln Highway


Left: Columbiana Co., Ohio, had 27 miles of this sort of thing. *Right:* This view, taken at another point near the Pennsylvania line, is representative of the kind of road that has replaced the muddy wagon trail of previous years.

Ohio roads before and after the 1921 campaign on the Lincoln route

tically finished and ready for use. I was the average man; I supposed that I could follow the pretty red-white-and-blue markers clear to Chicago just as easily as I could follow them to Princeton, with no more serious obstacles than an occasional detour, and perhaps a few miles of inferior road here and there.

From New York to Gettysburg and from Lima to Chicago this expectation was borne out by the facts. In the region between Gettysburg and Lima—well, it wasn't. My advice to motorists for 1922 is emphatic. Stay off this part of the Lincoln Highway until some one who loves you has been over it, and assures you that it is in shape to travel on. When it is finished, so far as one can judge from what is being done to it in Pennsylvania and Ohio, the enthusiastic forecasts of a concrete thoroughfare from New York to Chicago will be abundantly realized. Till then it is no place for anybody to go in an automobile.

Between Gettysburg and Pittsburg the objection to the Highway in its present state is simple. Parts of the route have been concreted, in accordance with the program of the Pennsylvania Highway Commission. With respect to the other parts concreting is a matter of the future; it will presumably be done in the near future, and there is no particular reason to suppose that the detour issue will be handled any more intelligently than it was in 1921. Until these links are concreted it is no kind of fun travelling them.

West of Pittsburg the situation is in general terms the same, but in its details it is far more annoying—at least, it was during 1921. In the first place, there isn't a single Lincoln Highway through Ohio. There are three or four places where the Highway has been or might have been or could be or where somebody wishes that it were: and all of these are marked with red-white-and-blue stripes of one design or another. You can't cut the Gordian knot by following the latest style of marker, because for about 100 miles between Massilon and Upper Sandusky this would take you along a route that is barred by detour signs for practically its entire length. Of course I am here speaking of 1921 experience; I was on the Highway just four times over this stretch—in passing through Wooster, Mansfield, Galion and Bucyrus. The city limits invariably produced a detour that lasted till we were approaching the next city. Moreover, in at least one case the Association has allowed itself to be cajoled into marking two alternative routes with the latest model of 1921 standard markers.

The forty-mile stretch immediately east of Mansfield was a nightmare. Plainly marked detours led to bridgeless bridges; detour signs ran out and left one to run for ten miles without guidance; one detour led along a concrete road in process of construction, on which the west bound car had to run off a four-inch curb on to a most disreputable old wagon track to let eastbound cars pass; and in general, everything that road construction can bring out to plague the passing motorist was brought out to its full degree of possibility. I am informed that in the neighborhood of the Ohio-Pennsylvania line there is another gap of some miles of the same general character, with the exception that the detours are even worse.

Mountain scenery on the transcontinental highway through Wyoming

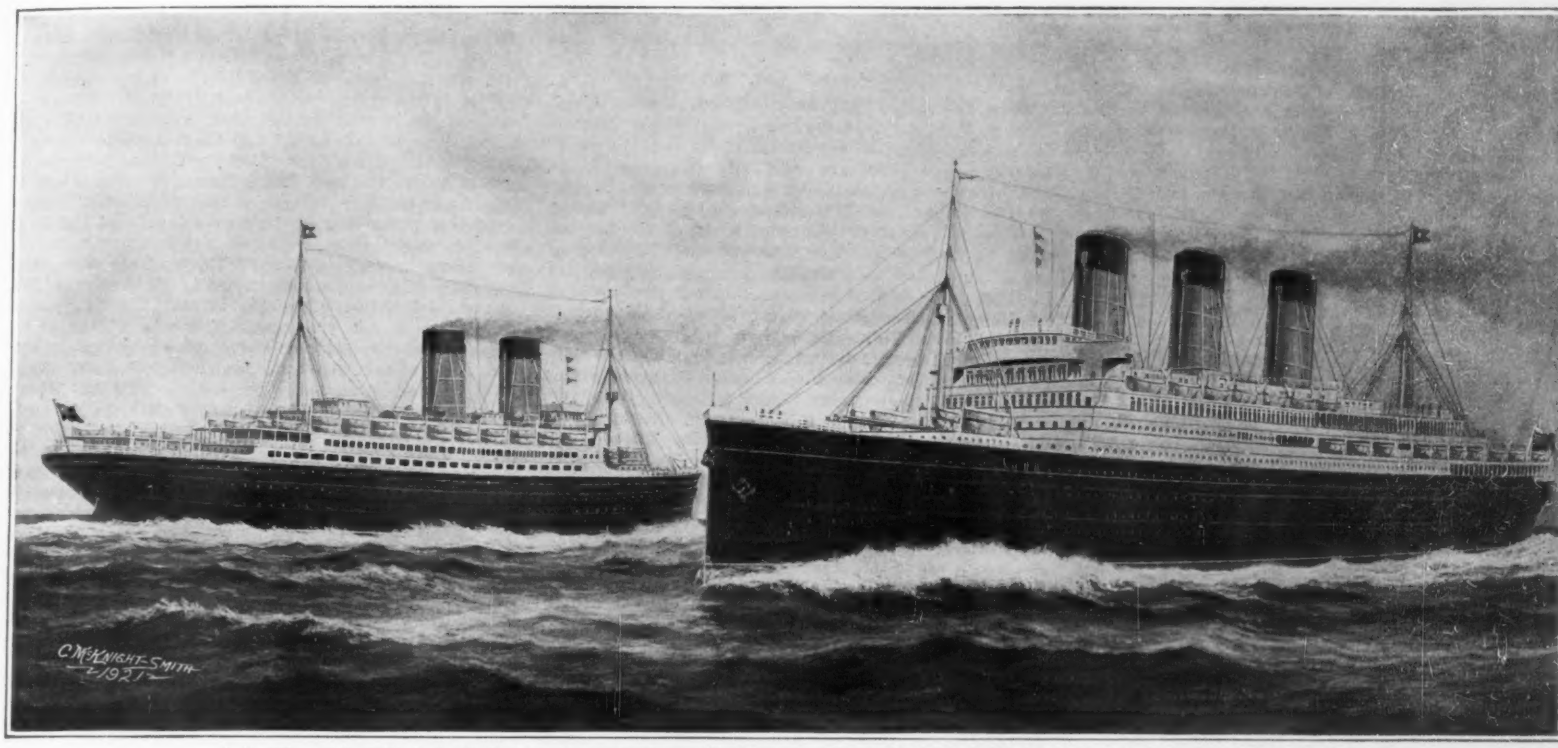
The impression that I got in running through this barricade was that the route could not possibly be got into shape by the end of the season of 1921. So I repeat; when the Lincoln Highway is finished it will be thoroughly good; but until you are assured by something more substantial than statements of the amount of money so far spent, you will best assume that it isn't finished, and aid in its ultimate completion by staying off it.

This leaves the question open of how to get across the country in an automobile. There are two ways, either of which, during 1921, was vastly to be preferred to the Lincoln Highway, and both of which lend the strong suggestion that their superiority will be more pronounced in 1922. The first involves using the Lincoln route as far as it is good—which is to say east of Gettysburg and west of Lima. If it is more convenient to pick up the northern loop of the Lincoln way (which leads here a double life), this can well be done at Upper Sandusky or any point west thereof, or perhaps as far east as Bucyrus. Between Gettysburg and the point where the main line is rejoined in Ohio, the old National Highway offers a route to which the most captious critic could offer no serious objection.

Through Maryland this route merits the adjective "superb." Superb in the condition of the road, clear through from Gettysburg via Waynesboro, Hagerstown, Cumberland, Uniontown, Washington (Pa.) to the West Virginia line, where twelve miles of bad road separate one from Wheeling; superb in its historic associations and its scenic attractions; and superb in its mountain-climbing features. In this connection the motorist ought to be warned not to leave Hancock bound west or Uniontown for the east with any little thing the matter with his car. These are real mountains, with long winding grades of 8 and 10 per cent, which compel the largest and most powerful cars to run largely in first speed and to stop half way up the longer pulls, to cool off and to permit the youth of the country to fill the radiators at 10 cents per fill. The highest elevation attained is Negro Mountain, a few miles west of Grantsville, Md.: 2,906 feet. The longest severe climb is three miles up Chestnut Ridge going east out of Uniontown; but going west, the road rises continually from Cumberland, 635 feet, to a point beyond Frostburg, 2300 feet. Nor is Cumberland the beginning; it is reached from the east only by severe climbs over at least two ridges, and less serious grades in profusion. And there are many double and triple curves of extreme sharpness. But the uniformly fine character of the road makes the trip a pleasure to anyone who is able to feel confidence in his car.

(Concluded on page 80)

Another scenic feature of the coast-to-coast tour; a point in Pennsylvania where several miles of the Highway is visible winding among the hills ahead



Left: "Homeric", 775½ ft. by 83 ft. is an improved "George Washington". *Right:* "Majestic", 933½ ft. by 100 ft., is an improved "Leviathan".

Two great passenger ships, now completing in Germany for the White Star Line

The "Big Five"

Our Bid for the Transatlantic Passenger Trade

IF you should drop into the headquarters of the Shipping Board in New York seeking information, or on a business call, you would probably hear more than once the phrase, "The big five." It is the Shipping Board's generic term for the largest and choicest of the transatlantic passenger steamers which were shut up in American ports and held there by the blockading force of British cruisers outside, and upon our entrance into the war were seized by the United States Government. After the Armistice we obtained permanent possession of these ships, which form the leading members of a fleet whose total tonnage amounted to some 600,000 tons.

Although it is an old story, we cannot forbear making reference just here to the very able work which was done by our Navy Department in repairing the wreckage which had been wrought upon the engines of most of these ships by their German officers, just prior to our entrance into the war. Steam cylinders and steam-chests, from which the Germans had smashed large fragments, were repaired by electrically welding new sections in place and reboring and refacing them. The repairs were so efficient that we were able to put the whole of the fleet, or as much of it as we wished, into our transport service, and the vessels did yeoman work in carrying our Army across the Atlantic.

After the Armistice the various transports, or most of them, were tied up to different docks until the Shipping Board was able to overhaul the engines and restore the interior passenger accommodations. Much of this work has been done, and some of the largest of the ships are today in operation. Upon others, the work of reconditioning involves so much expense that it has not yet even been commenced. Conspicuous, of course, among these is that great ship, the "Leviathan." In the order of their size and importance, the "big five" are: the "Leviathan," the "George Washington," the "America," the "Agamemnon," and the "Mount Vernon." And for the particulars of these vessels, reference is made to the accompanying table.

Particulars of the Shipping Board's "Big Five"

	Leviathan (Ex-Vaterland)	Geo. Washington	America (Ex-Amerika)	Agamemnon (Ex-Kaiser Wilhelm II)	Mount Vernon (Ex-Kronp'n Cecilie)
Length of deck, feet..	927½	699	669	684¼	685¼
Beam, Feet	100	78	74	72¼	72¼
Depth, feet	57.1	50.1	47	40	40.5
Gross tons	54,292	23,788	21,144	19,360	19,503
Speed, knots	23	17	16	23	19
Passengers, first	......	485	450	600	600
Passengers, second ...	......	440	250	320	301
Passengers, third	......	1,771	1,500	663	657
Total..............	......	2,696	2,200	1,583	1,558

Leading particulars of the five large passenger ships with which the United States Shipping Board will compete for the transatlantic passenger trade

The "Leviathan"

With the single exception of the "Majestic," which has been assigned by the Shipping Board to the International Merchant Marine for operation, the "Leviathan" is the largest ship afloat, the "Majestic," (ex-"Bismark") is six feet longer. These two liners were built side by side upon the building way of the firm of Blohm and Voss at their celebrated Hamburg yard, from the designs of Dr. Foerster, the chief naval architect of the Hamburg-American Company, for whom the ships were constructed. The "Leviathan," then the "Vaterland," made her maiden trip to New York in the early summer of 1914, and after two or three voyages, the war found her at the Hamburg-American dock at Hoboken, where she remained until the Spring of 1917. The "Leviathan" is 927½ feet long on deck; her beam is 100 feet; and her molded depth is 57.1 feet. The gross tonnage is 54,292 tons, and the four turbines of 90,000 horsepower, driving four shafts, were designed to give her a speed of 23 knots, which she is able to make today.

The ship was most sumptuously furnished and decorated in the German style, the special features being a large assembly room about 75 x 55 feet and about 25 feet high, which is entirely free from supporting columns, the great roof being carried by overhead plate girders, extending from side wall to side wall. Another remarkable feature is the Ritz-Carlton restaurant of about equal width and height and about 55 feet wide. There is also a main dining room which measures about 115 feet by nearly 100 feet. Below decks is a Pompeiian swimming pool and a series of electric baths, massage rooms and other equipment of the same character.

In preparing the ship for transport service a large number of her elaborate private cabins were torn out to make way for pipe berths for the men; and so far as her decorations were concerned, she was subjected to that all-around wrecking which is involved in turning a passenger vessel of this kind into a transport.

The "Leviathan" Well Cared For

Contrary to the popular impression, which has been created by irresponsible newspaper reporters, the "Leviathan" has been very well cared for during the three years in which she has lain at the Hoboken docks. A force of some 200 men has kept the machinery, including the main engines, auxiliary pumps, et cetera, in first-class condition. They have been periodically inspected, turned over, and protected against deterioration; and, thanks to the excellence of this care, the ship at a few hours' notice would be able to steam out of her dock and make her maximum speed of 23 knots. Also, the talk about this valuable ship rusting at her moorings is sheer nonsense. She has been cared for by the International Merchant Marine under a contract with the Shipping Board, and the patches of red lead paint with which she is disfigured are evidence of the fact that rusting is just the one thing against which the care-taking crew are guarding. The hull is in fine condition, for the ship was built of the best materials and with the careful workmanship which characterizes the best German shipbuilding yards.

At the same time, it must be confessed that the "Leviathan" is something of a "white elephant;" for it would take between six and seven million dollars to reconstruct the interior passenger accommodations of the ship and refit her to meet American ideas of comfort, decoration and sanitary arrangements. The work would be enormous, involving the construction of many miles of electric cables, the complete overhauling of her

baths and sanitary and general plumbing arrangements, and the redecoration of her great assembly and dining halls and the vast suite of private cabins. She stands as a monument to the folly of the Shipping Board during the early part of its administration; for it is a fact that the International Merchant Marine Company made a bid of four million dollars for this ship—a reasonable offer if we bear in mind the enormous cost of her reconditioning. This was turned down, and Heaven alone knows what will become of the ship! Any firm that bought her would have to spend six or seven million dollars upon her and would be hard put to it, even with full cabins, to get any profits out of the venture.

The "George Washington"

The next largest ship, the well-known "George Washington," in which the President of the United States so frequently crossed to France during the peace negotiations, has been entirely renovated and is now in service. The engines and general mechanical plant are in first-class condition, and she has been entirely rebuilt and redecorated throughout. This ship belongs in that class which used to be called "intermediate express steamers," in which a large freight-carrying capacity is combined with commodious passenger accommodations. The "George Washington," according to the American register of ships, is exactly 690 feet in length; her beam is 78.2 feet, and her molded depth, 50.1 feet. Her gross tonnage is 23,788 tons, and her engines of 20,000 horsepower, drive the ship at a sustained sea speed of 17 knots. She has accommodations for 485 first-class, 440 second-class and 1,771 third-class passengers—a total of 2,696. The cost of renovating the interior of the ship was $2,000,000.

The "America"

Another fine vessel of the same class, built by Harland and Wolff, of Belfast, but older than the "George Washington," is the "America." Her dimensions are: Length of deck, 669 feet, beam 74 feet, molded depth, 47 feet. Her gross tonnage is 21,144 tons, and she is capable of a sustained sea speed of 16 knots. She can carry 450 first-class, 250 second-class and 1,500 third-class passengers. The engines of the "America" have been partially rebuilt and subjected to a thorough overhauling, and today are in excellent shape. Passenger accomodations have been entirely rebuilt and redecorated, and this part of the work is attractive, highly artistic and very restful to the eye.

The "Mount Vernon" and "Agamemnon"

These two ships, built for the North German Lloyd Line, in their day held the blue ribbon of the Atlantic conjointly with the "Deutschland" of the Hamburg-American Line. They are practically sister vessels, and under the German flag they were known as the "Kaiser Wilhelm II" and the "Kronprinzessin Cecilie." "Kaiser Wilhelm II" equalled the record speed of 23 1-3 knots made by the "Deutschland" for the whole crossing of the Atlantic, and both ships were exceedingly popular in their day. After they came into the possession of the Shipping Board they were overhauled. The work on the "Mount Vernon" (formerly the "Cecilie") was done at the Boston Navy, where the engines were overhauled from the engine foundations up; they are now in first-class running order. Work on the "Agamemnon" was done at the New York Navy Yard. Renovation of the cabine accommodations in these two vessels is not yet complete; but we understand it is to be put through by firms acting under contract with the Shipping Board. The dimensions of the "Agamemnon" are: length 684.3 feet; beam, 72.3 feet; depth, 40 feet; gross tonnage, 19,360 tons, and the engines today are capable of driving her at a speed of 23 knots. She has accommodations for 600 first-class, 320 second-class, and 663 third-class passengers.

The five ships mentioned above, with the exception of the "Leviathan," have been operated under contract with the Shipping Board by the lately defunct United States Mail Service. At present they are being operated by a company of patriotic officials, who are giving their services for nothing, the company receiving a certain sum from the Shipping Board to cover the expenses of running the ships.

The "Majestic" and "Homeric" of the White Star Line

When the war broke out, the "Bismarck," sister-ship to the "Leviathan," then known as the "Vaterland," was under construction at the Blohm and Voss yards at Hamburg. Little was done upon her during the war; but since the Treaty representatives of the White Star Line and of the German builders are working together to outfit her with stores and minor equipment. She will be operated for the Shipping Board who will pay the company a certain sum for that service. On taking her place in the New York-Cherbourg-Southampton service, she will conform in the details of her passenger fittings to the standards of the "Olympic," with which she will ply in that service. She is about 10,000 tons larger than the "Olympic," and about 2,000 tons larger than the "Leviathan," or 56,000 tons. The increase in size is due to the fact that after she was designed, it was determined to introduce two additional frames amidship, giving her an increased length of six feet, so that, according to the American Maritime Register, her length on deck will be 933.6 feet. This great ship will have 1,245 staterooms, including 472 first-class, 212 second-class and 561 third-class cabins. The dimensions of the vessel are enormous. The tops of the three smokestacks are 144 feet above the water line of the ship and 184 feet above the keel, which is about equal to the height of an ordinary 14-story building. There is a great suite of halls on the boat deck, including a lounge 26 feet high, with floor dimensions 76 by 64 feet. The main dining room is 117 feet long by 98 feet wide, and its ceiling is 31 feet high. The first-class restaurant is 110 feet long by 54 feet wide, with a ceiling 23 feet high. There is an unbroken view through the center of these halls of 250 feet. This is made possible by the arrangement of the uptakes to the smokestacks, which are brought up, from the boiler rooms, near the sides of the ship in two parts which unite above the saloon deck. The grand staircases are also built on the sides instead of in the center of the vessel. These arrangements insure a clear sweep of unimpeded space throughout the great public rooms. The estimated sea speed of the ship is about 23 knots, though it is probable that, in common with all big, fast passenger steamers today, she will be run at a lower speed than that in order to economize fuel. Including her crew of over 1000 men, the full complement of the ship will be more than 5000 souls.

Another fine ship that will be operated by the International Merchant Marine is the "Homeric" (formerly the "Columbus"), which was practically completed for the North German Lloyd Line at the outbreak of the war. She was designed to be an improvement on the "George Washington," which she resembles in general appearance. She is 775.6 feet long; her beam is 83.1 feet and draft 33.8 feet. The gross tonnage is 32,000.

The Chemistry of the Volatile

Some Interesting Facts About a Relatively Obscure Phase of Chemistry

By Dr. Alfred Gradenwitz

WHILE carbon with its inexhaustible wealth of compounds constitutes the basis of organic life, two other elements, boron and silicium, its immediate neighbors in the Periodic System, so far exhibited a paradoxical behavior by the extremely limited number of reactions they seemed to be capable of. Just imagine the enormous number of about two hundred thousand carbon compounds, natural or artificial, and on the other hand, in Nature, nothing but the rigid, mineral boric and silicic acids, and in the laboratory, a trifling number of compounds almost without an exception showing no analogy with those of carbon.

The admirable researches carried out of recent years at the Kaiser-Wilhelm Institute of Chemistry (Dahlem near Berlin), by Prof. Alfred Stock, in conjunction with Dr. Kuss and other fellow workers, have changed all this by the discovery of a wonderful variety of compounds showing a close analogy with those of organic chemistry, the apparent inertia of boron and silicium being due to the extremely volatile and ephemerous nature of most of these compounds.

These somewhat unexpected results were reached by a special and most refined method of experimenting, which enables such volatile substances in minimal quantities (some tenths of a gram) to be handled, cleansed, analysed, their physical constants to be ascertained, and their chemical behavior to be studied under perfect seclusion of any air, fat or moisture.

Experiments are carried out in a high vacuum, in glass tube outfits having all their parts joined by blowing, while the ordinary fat-tightened taps are replaced by a special type of mercury valve. These glass tube systems, combined in accordance with the requirements of each case, comprise amongst other things: High speed air pumps for exhausting, self-acting mercury air pumps for the collecting of gases, different types of vessels for performing reactions and analyses, separating mixtures (by fractionated distillation or condensation), determining melting points and densities of gases and liquids, storing gaseous and liquid products, manometers and checking barometers, arrangements for weighing these substances, heating them, introducing them into closed tubes and back again into the glass tube outfit, etc. All these operations are carried out without the substances ever coming into contact with air. These volatile substances can within the glass tube outfit be transferred to any place previously cooled with liquid air, a few seconds being sufficient for them to be condensed entirely. Liquid cooling baths or metal blocks cooled with liquid air are used to produce the temperatures required in the various parts of the outfit for fractionated distillation or the life, while a determination of gas tension, carried out with the simplest possible means and without any loss of substance, serves to test the purity of and to identify these volatile substances. The strictest care is taken to insure absolute purity of the original substances used for reaction, the use of dissolvents being avoided as far as possible, while any materials subject to decomposition are for further treatment permanently stored in liquid air.

While this vacuum process is rather exacting with regard to space, time and expenditure and requires a special technique only to be mastered by experienced workers, the outfit, once installed, will enable minute amounts of material to be utilized with surprising economy. The process will supply the most accurate data as to the purity of substances, the composition of mixtures, the mechanism of reactions. When striking the balance of a completed series of tests, all the components of the original materials will be found back again in the terminal productions to within fractions of a milligram. Prof. Stock does not hesitate to affirm that whoever once has become familiar with the new method will even prefer it in cases where larger amounts of material might as well have been treated according to classical chemical methods.

The new method greatly extends the limits of accuracy in connection with chemical synthesis and analysis. Wherever Stock and his assistants with its aid checked existing physical data, as recorded in literature (melting points and tensions), the material used in connection with previous tests was found not to have been sufficiently pure. In fact, many problems on which much time and thought have been bestowed could be settled immediately by means of the vacuum process.

The remarkable results of these investigations enable the special chemical relationship between carbon and its closest neighbors in the periodical system, boron, silicium and nitrogen, to be ascertained in all details. The *individual* chemical faculties of each of these three elements are, as Stock puts it, "in the case of carbon *combined* in a maximum of perfection and harmony."

In the case of boron and silicium there is a prevailing affinity for oxygen, in that of nitrogen a prevailing hydrogen affinity. With carbon, there is about equality of hydrogen and oxygen affinities, its power of binding hydrogen and oxygen simultaneously in variable proportions and forms being of the highest importance for the organic world. With nitrogen, carbon shares the volatility of natural simple compounds. The same as ammonia in the case of nitrogen, carbon dioxide in the case of carbon is the cause of permanent chemical cycle. After its migrations through vegetable, animal and human organisms, carbon will over and over again manifest itself in the form of carbon dioxide, penetrating in this volatile form wherever new chemical reactions are waiting for it.

Boron and carbon show a close analogy in their power of aggregating large numbers of their own atoms into stable molecular complexes, "chains", "rings", etc. Like silicium, carbon possesses the faculty of polymerising small molecules into large non-volatile ones.

This much can be asserted on the strength of Stock's experiments, that the chemical character of carbon is only quantitatively, not in principle, different from that of other elements.

Naval Strength of United States, Great Britain and Japan

How Age of Ships Will Affect Relative Fighting Efficiency by 1924

By J. Bernard Walker

ALL comparisons of the relative strength and efficiency of warships are more or less unsatisfactory. One ship may have high speed and great gunpower, but be weak in armor and underwater subdivision; another will sacrifice speed to gunpower and armor; and yet another will have abnormally high speed, combined with light armor, moderate gunpower, and fairly good subdivision.

In the presence of this bewilderment, naval writers, both inside the Navy and out, have developed various ingenious schemes for allotting certain index values to the separate elements of warship efficiency, and thereby reaching a final number which represents to what degree a given vessel is 100 per cent efficient. This system is tedious and arbitrary; for there is no general agreement as to the relative values of guns, armor, underwater subdivision and speed.

The SCIENTIFIC AMERICAN has long held the opinion that the only single basis of comparison of the fighting one, the displacement, which, *at the date of a ship's completion only*, has a clearly defined value.

Displacement Value As Modified by a Ship's Age

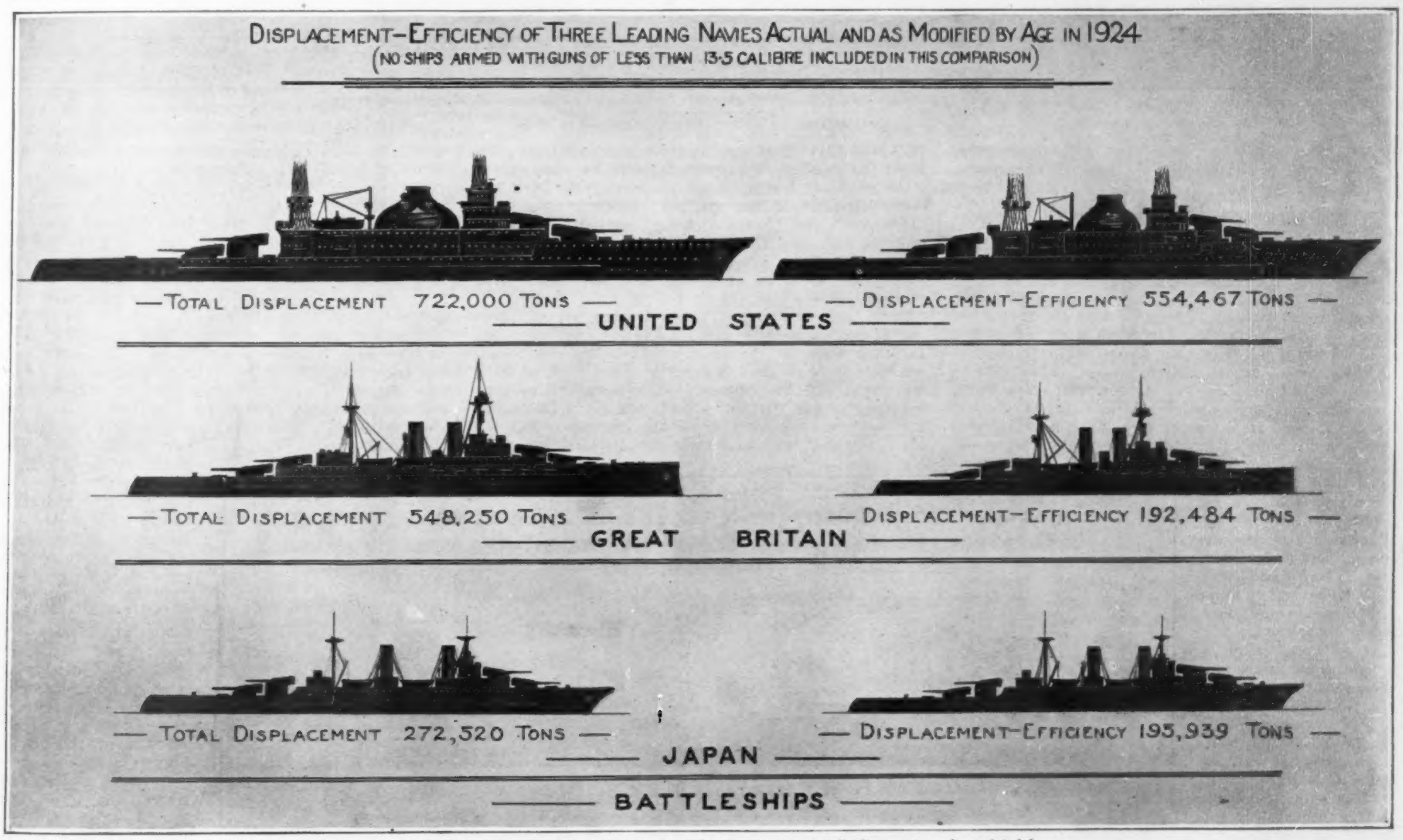
In an article published in the SCIENTIFIC AMERICAN of February 12, 1921, we compared, upon a straight displacement basis, the relative strength of the three leading navies as they stood on that date and as they will stand in 1924. This comparison shows that if the nations concerned complete their shipbuilding programs the United States will lead, with Grain Britain second and Japan third.

Now, although that comparison on the basis of mere displacement is accurate so far as it goes, it does not go far enough; inasmuch as it does not give us a true picture of the relative *military* efficiency of the three navies. There was left out of the comparison an element which is more potent, far more potent, in determining the value of ships that are armor, guns, sub-

mean that warships, any more than automobiles, are poorly built, or that inferior materials enter into their construction. Quite the contrary. No fabric that floats upon the high seas embodies within it such skilled design, such carefully selected materials as a modern warship. More than that, there are no vessels, not even the finest in the mercantile marine, that receive such careful upkeep or have such great sums for refitting expended upon them at regularly recurring periods as a warship.

Warship Depreciation Due to New Inventions

The rapid aging of the battleship and battlecruiser is due not to material, but to military depreciation, and military depreciation is due in large measure to naval invention. Naval invention, coupled with the skill of the naval constructor, is carrying the progress of the naval art along so rapidly that, after ten years of service in the first battle line, a capital ship must be



Drawings at left: Comparison by displacement. *At right:* Comparison by displacement as depreciated by age

Comparison of battleship strength in 1924

value of two ships that comes pretty close to the truth is that of displacement. The naval designer may add good quality to good quality in building up his plan; but he can never afford to forget that he has to float this aggregation upon the high seas; and flotation means displacement, and displacement is determined for him mainly by the depth of the national purse.

Displacement As Basis of Comparison

In the earlier years of the development of steel navies, there was a much greater diversity in warship design than there is today. Naval construction was feeling its way. The art is now so highly developed, the principles so well established, and designers in the leading naval countries are so closely in touch with one another, that it is safe to say that a thousand tons of displacement has a fairly constant value, whether it be in a Japanese, British or United States ship. Furthermore, of all the elements included in those detailed analyses of ships to which we have referred above, there is just division and speed. *We refer to the question of age, and the undisputed fact that, from the day a warship takes the water, there sets in a steady and very swift depreciation of her military efficiency.* It follows, therefore, that when you have completed your calculations of the fighting efficiency of two ships, on a basis of displacement, you are still very far from a final and accurate conclusion. That can be arrived at only when certain deductions have been made from her efficiency, proportionate to the years which have elapsed since she was completed.

Capital Ships Obsolete in Fifteen Years

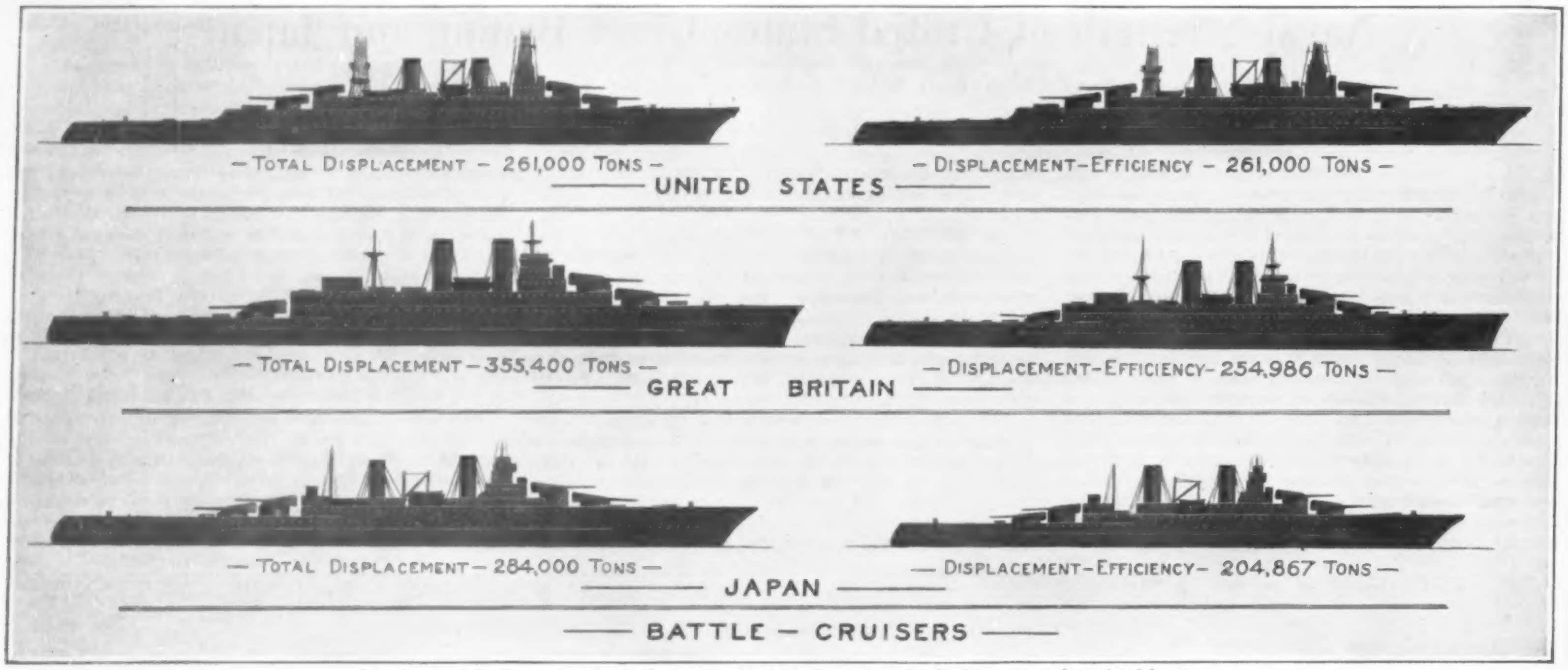
Every owner knows that an automobile depreciates, steadily, from the day on which it is bought; but not many people outside of the Navy realize how short is the effective life of a warship—how rapidly she slides down the scale of efficiency and reaches a period when she must be written off the naval lists as obsolete.

Just here it should be made clear that this does not

relegated to the second line, and in fifteen years is ready for the scrap heap. Furthermore, development seems to proceed not upon arithmetical but upon geometrical lines, with the result that the more modern the ship the shorter is her tenure of useful military life.

Age Depreciation and Rising Cost of Navies

This rapid military depreciation of ships due to unforeseen inventions, for which, in the nature of things, no provision can be made in the ship at the time of her construction, is a fruitful cause of the continual increase in naval budgets, to replace ships that age has eliminated. To this must be added the rapid increase in the size of ships, to say nothing of the growing costs of labor and material. It is the realization of these facts that is responsible, in no little degree, for the growing reluctance of the taxpayer to put his money into such mastodon warships as the "Indiana", the "Hood" and the Japanese "Amagi." The man on the street realizes that competition in building must cease



Drawings at left: Comparison by displacement. *At right:* Comparison by displacement as depreciated by age

Comparison of battle cruiser strength in 1924

or the nations will be confronted with bankruptcy.

Competition in armaments has reached a veritable *reductio ad absurdum*.

The Logic of Our Tabular Comparisons

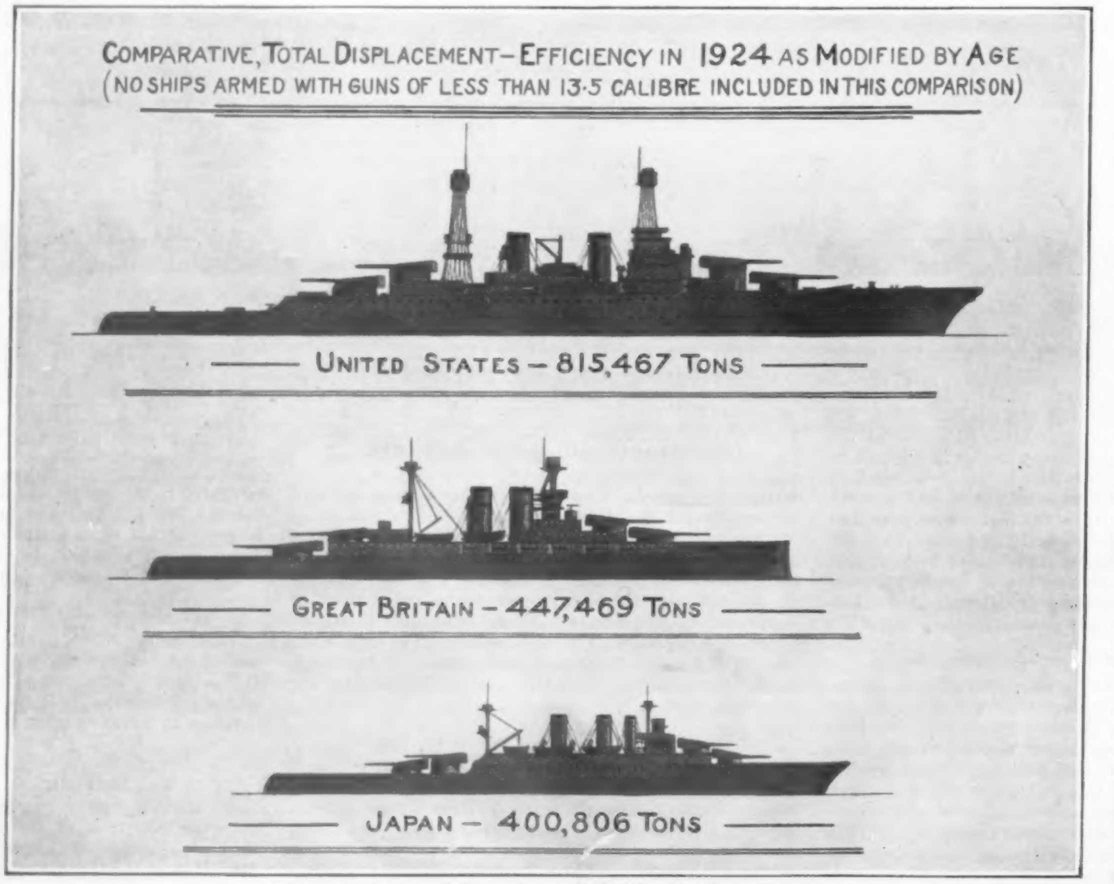
To test out the influence of age upon efficiency and get some exact figures, the writer recently drew up the accompanying tables, showing the actual age of existing battleships and battlecruisers by the year 1924; and the result was so interesting that the tables are here presented in detail. The method of comparison is based upon the fact that a battleship is obsolete in fifteen years, if not, indeed, sooner. Proof of this is seen in the fact that the eight capital ships which Great Britain recently announced in Parliament she had decided to send to the scrap heap were from thirteen to fifteen years old, with an average age of 13½ years. They were eliminated because their 12-inch guns were too feeble to be opposed to the 14 and 16-inch guns of modern ships; their underwater subdivision inefficient against the modern mine and torpedo; and their armor insufficient.

If a capital ship is worthless for active service in fifteen years—that is to say, if she is at 100 per cent efficiency on the date of her completion and has zero per cent of efficiency in fifteen years, we take it that a reasonable way to get at her efficiency at any period in the interim is to find out how many years of life are still left to her. Thus, a ship five years old will be two-thirds efficient; a ship ten years old, one-third efficient; and so on.

It should be noted that the date of completion of the newest ships in these tables is assumed. In the case of our ships of the "Indiana" class, it is based on their present degree of completion, which renders it unlikely that any of them will be in commission before 1924. The four vessels of the "Maryland" class, by 1924 will have spent one to three years of their life. Even the flagship "Pennsylvania" will have consumed eight years of her life, and therefore will have but seven-fifteenths of her original efficiency; while the "Delaware" and "North Dakota," our earliest dreadnaughts and once the pride of our Navy, will be 14 years old and but one-fifteenth efficient. In all probability we shall do as the British have done, and condemn, before 1924, the six vessels of the "Arkansas", "Utah" and "Delaware" classes, since all of these carry only a 12-inch gun. Therefore, we have not included them in the total of 21 battleships which we shall have on that date. The grand total of what we might call the efficiency-displacement as reduced by age, for our battleship fleet, will be 554,467 tons. Our six great battlecruisers, being brand-new like the six "Indianas," will have their full displacement value of 261,000 tons, making a grand total for the United States of 815,467 tons efficiency in capital ships.

The British fleet totals, as given in our article of February 12, 1921, have been modified by omitting the capital ships that have been ordered scrapped since that article was written, and by including the four new battlecruisers whose construction is soon to be commenced. These vessels will resemble the "Hood." They will have less speed but greater gunpower than that ship; and they will embody such lessons of Jutland and of post-war experience and investigation as have not been included in the "Hood." These elements will include the usual bulge protection against mines and torpedoes, and an armament of 16-inch guns mounted in triple turrets (not 18-inch guns, as so often reported.) Particular attention will be paid to horizontal armor. The speed will probably be about 28 knots as compared with the 31½ knots of the "Hood"; and it is likely that their displacement will be about the same as, or a little more than, that of our "Indiana." Consequently, we have put them down at 45,000 tons each; and as they should be just about completed in 1924, they are included at full displacement-efficiency value among the British battlecruisers.

By the time the contracts for the four capital ships are let, Great Britain will have done no new warship construction for three years, during which time her existing fleet has experienced three full years of depreciation. The consequence of this is shown very forcefully in the total displacement as modified by age, which drops from 548,250 tons to 192,484 tons. Had it not been decided to scrap the six battleships armed with the 12-inch gun, their age-displacement value would have been so low, that it would have added less than 15,000 tons to the total. Similarly, among the battlecruisers, even



Relative fighting efficiency in capital ships by close of 1924

the "Hood" will have lost **four years of her usefulness** by 1924. The two fine ships "Repulse" and "Renown" will have lost eight years; the "Tiger," with ten years gone, will have only one-third efficiency. The "New Zealand" and "Australia", carrying 12-inch guns will have been eliminated; so that the grand total of battle-cruiser efficiency will be 254,986 tons.

In the Japanese tables are included four battlecruisers of the "Amagi" and "Atago" classes, and the sister battleships, "Kaga" and "Tosa." Four of these vessels, all of over 40,000 tons displacement, will carry practically their full efficiency value in 1924. The battleship "Settsu", a 12-inch gun ship, has been omitted from our list.

All Nations Must Slow Down, or None

These comparative tables, showing the effect of age on efficiency, teach most eloquently the lesson that a naval power must build to the limit in size and build uninterruptedly, or she will quickly begin to go under. Age will tell; as shown by the big drop of the British battleship totals (due to age) from 548,250 to 192,483 tons. Also, the tables prove that no single power can afford to disarm alone. It must be done jointly, by agreement, and pro rata; that is to say, the strength of the navies must be determined by a most careful, broad-minded and unprejudiced consideration of the several responsibilities of the naval powers that may be represented at the forthcoming conference in Washington.

Preponderance of United States in Capital-Ship Strength

We do not know of any stronger argument against the immediate completion of our six ships of the "Indiana" class than is presented by these comparative tables, and *particularly when they are viewed in the light of the fact that we have declared for a policy of equal strength with that of any other navy.* Today, or rather by 1924, if the present programs of construction of the three leading naval powers are completed, we shall find ourselves in the position of being about equal in capital-ship efficiency to the other two naval powers combined. This would be in flat contradiction of our avowed policy. The great inferiority of the British navy in capital ships will be somewhat compensated by her fine fleet of scout cruisers, a type in which, by 1924, we shall be relatively deficient. Her navy is also superior in its aircraft material, since it includes several aircraft carriers and a fleet of scout and bombing planes. A vital branch of our naval establishment which should be developed is the submarine service. There seems to be a common agreement in the Navy that this service, so far as material is concerned, is below the standard of the rest of our fleet.

The Moral of the Above Comparison

The supreme lesson taught by the tables given above is the one that has been so frequently emphasized in previous issues of the SCIENTIFIC AMERICAN, namely, that we should spend our future effort in balancing our present ill-balanced navy, going slowly on battleship construction, rushing the battlecruisers to completion, laying down additional scouts, and building up our submarine service to the point where it balances with the rest of the fleet.

If we complete the six "Indianas" at once, our navy will be topheavy. Wisdom dictates that we should direct the money that they would cost to building up our navy where it is weak.

The battleships can wait. A liberal coat of grease and red lead will prevent deterioration until we resume their construction. The contracts can be adjusted without any such absurd figures of loss as have been predicted.

Furthermore, the money directed from the battleships can be used to advantage in larger supplies of ammunition for target practise, in intensive training of the personnel, and in holding together our fine Naval Reserve—one of the valuable legacies of the war.

TABLE SHOWING RAPID DEPRECIATION OF CAPITAL SHIPS THROUGH AGE

No Ships Armed with Guns of Less than 13.5-Inch Caliber Included in These Tables

	Date Completed	Displacement, Tons	No. in Class	Total Displacement of Class	Age in 1924	Percentage of life remaining in 1924	Displacement Efficiency, 1924, as Reduced by Age
United States							
Battleships—							
Indiana	1924	43,200	6	259,200	0	15/15	259,200
Maryland	1921	32,600	1	32,600	3	4/5	26,080
Colorado	1922	32,600	1	32,600	2	13/15	28,254
Washington ...	1922	32,600	1	32,600	2	13/15	28,254
West Virginia..	1923	32,600	1	32,600	1	14/15	30,427
Tennessee	1921	32,300	2	64,600	3	4/5	51,680
New Mexico ...	1918	32,000	1	32,000	6	3/5	19,200
Idaho	1919	32,000	1	32,000	5	2/3	21,333
Mississippi	1917	32,000	1	32,000	7	8/15	17,067
Pennsylvania ..	1916	31,400	2	62,800	8	7/15	29,306
Oklahoma	1916	27,500	2	55,000	8	7/15	25,666
New York	1914	27,000	2	54,000	10	1/3	18,000
Totals........			21	722,000			554,467
Battle Cruisers—							
Constellation ..	1924	43,500	6	261,000	0	15/15	261,000
Great Britain							
Battleships—							
Royal Sovereign	1916	25,750	5	128,750	8	7/15	60,083
Queen Elizabeth	1915	27,500	5	137,500	9	2/5	55,000
Benbow	1914	25,000	4	100,000	10	1/3	33,333
Erin	1914	23,000	1	23,000	10	1/3	7,668
King George ...	1913	23,000	3	69,000	11	4/15	18,400
Orion	1912	22,500	4	90,000	12	1/5	18,000
Totals.......			22	548,250			192,484
Battle Cruisers—							
Enlarged Hoods	1924	45,000	4	180,000	0	15/15	180,000
Hood	1920	41,200	1	41,200	4	11/15	30,213
Repulse	1916	26,500	2	53,000	8	7/15	24,733
Tiger	1914	28,500	1	28,500	10	1/3	9,500
Lion	1912	26,350	2	52,700	12	1/5	10,540
Totals.......			10	355,400			254,986
Japan							
Battleships—							
Kaga	1923	40,600	2	81,200	1	14/15	75,787
Negato	1921	33,800	2	67,600	3	4/5	54,080
Ise	1918	31,260	2	62,520	6	3/5	37,512
Fuso	1915	30,600	1	30,600	9	2/5	12,240
Yamashiro	1917	30,600	1	30,600	7	8/15	16,320
Totals.......			8	272,520			195,939
Battle Cruisers—							
Amagi	1923	43,500	2	87,000	1	14/15	81,200
Atago	1924	43,500	2	87,000	0	15/15	87,000
Kongo	1914	27,500	4	110,000	10	1/3	36,667
Totals.......			8	284,000			204,867

COMPARATIVE STRENGTH IN 1924, AS MODIFIED BY AGE

Ships Carrying 12-Inch Guns Not Included

	Battleships	*Battle Cruisers*	*Totals*
United States	554,467	261,000	815,467
Great Britain	192,484	254,986	447,469
Japan	195,939	204,867	400,806

A capital ship is obsolete in fifteen years. The above estimates of efficiency in 1924 are based upon the number of years of useful life remaining to each ship in the three navies

Table showing loss of efficiency through age

The Cricket on the Wire

ONE of the most fascinating fields of scientific study at the present time is that of animal psychology. For a number of years the workings of the mind of the higher animals, and particularly of the domesticated animals, including the dog, the horse, the elephant, the monkey and the parrot, have engaged the attention of large numbers of investigators. Likewise, the study of animal psychology has thrown some interesting light upon that of human beings, both of adults and of children, but it is comparatively recently that attempts have been made to study insects from this point of view. Not long ago a learned German scientist, Prof. Regan, made certain curious experiments with the ordinary field crickets by means of the telephone. We are indebted to a writer in *Kosmos* (Stuttgart) for an account of the very interesting tests made and their remarkable results.

The experimenter began by enclosing four square meters of the floor of a room with glass plates. Within this enclosure he placed the receiver of a telephone, and likewise at some little distance from the latter, a glass vessel whose sides were covered with black pepper and which contained a male cricket. The insect at once began to chirp loudly, whereupon an unmated female cricket was set upon the floor. The newcomer slowly and cautiously made her way toward the invisible musician, but just then the professor lowered a bit of wire gauze over the top of the glass vessel containing the male cricket, which frightened the latter into silence. Meanwhile another male had been placed in a distant room of the same building and provided with a small ball microphone connected with a very sensitive box telephone.

No sooner had the voice of her first admirer been stilled than the female cricket heard the voice of her second male insect issuing from the telephone. She at once turned her back upon the glass vessel which she had been approaching and moved somewhat hesitatingly but in the right direction toward the telephone. Upon arriving at a distance of barely a centimeter from the receiver, she halted and appeared to listen intently to the distant serenade. This experiment was repeated a number of times with other pairs of crickets and always with the same success. Eventually it was found to be not necessary to begin with the voice of the first cricket confined in the "glass house." These experiments while amusing in themselves are made with a serious object and the results are instructive. They prove to begin with the delicate sensitiveness of the telephone even with regard to the sounds made by the lower animals. They also reveal hitherto unknown facts regarding the sense of hearing and the mental qualities of insects. When the first experiments were made a loud tone telephone with a suitable microphone was employed, but it was found that this was inadvisable because of the delicacy of the organs of hearing in insects. It was discovered, too, that these organs are not situated in the antennae, as was formerly supposed, but in the lower segments of the forelegs. When these segments are lost, the insect finds it difficult if not impossible to perceive the call of its mate. These pseudo "ears" contain microscopically small strings resembling parchment in their nature and set into the rigid chitin shield. The sound waves which strike these strings are carried through a small tube to the minute auditory apparatus of the insect, which resembles on a small scale a series of organ pipes. From these the vibrations are carried by special nerves to the brain. As will be seen this arrangement suggests that of the nerves in the cochlea of the human ear. However, the tones given forth by insects are, most of them, so extremely high as to be imperceptible by human ears.

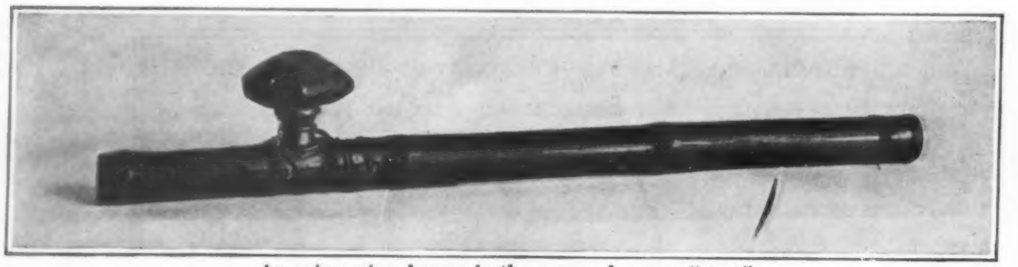
The peculiar chirping sound uttered by the male cricket is made possible by the circumstance that the left wing cover is almost entirely covered by the right wing cover. This enables the insect to draw the right wing with an idented cross vein across a smooth outstanding vein on the top of the lower wing cover, with much the same motion as that of the bow of a fiddle. The sound thus produced is extremely faint in itself, but it is greatly strengthened by means of four resonant bits of parchment-like skin so that it can be heard for a distance of more than 100 meters (about 330 feet). It must be remembered that while the note sounds very monotonous to human hearers, it is not so to the crickets themselves. This is shown by the fact that if a note be blown upon a pitch pipe of exactly the same height as the note made by the cricket, the animal makes no response to it, since its chirping is a far more artistic as well as a complex sound.

From Opium to Hash Eesh

Startling Facts Regarding the Narcotic Evil and Its Many Ramifications Throughout the World

By Dr. Carleton Simon

Special Deputy Police Commissioner in Charge of the New York City Police Narcotic Division



An opium pipe, known in the vernacular as a "stem"

"AND the opium came from the East where the fragrant poppy perfumes the air and where languorous dreams disguise the grind of dull monotony . . ." I might add to this thought: And now comes hash eesh, an ancient drug, new to America, and one that would make a wooden Indian love a granite boulder. It is probably the most violent of sexual stimulants, which accounts for its popularity. It is usually mixed with gum opium.

Before I go further into the subject of drugs and dreams, if a whimsicality is pardonable, I would mention here, the literature of drug addiction. Few people know there is such a literature. Do you remember De Quincy's "Confessions of an Opium Eater?" Here is a typical Chinatown lyric, abbreviated from a poem by George Hull, a writer of underworld fiction. Hull, by the way, is the son of an East Indian Missionary:

"Dr. Fat of Chinatown, he makes fat people lean,
In the purple haze of a poppy daze,
'Neath dragons gold and green,
He sings his song, the whole night long:
'Six-bittee hop for you?' he cries, 'and four bittee hop for you?'
'You never hittee the pipe before, two bittee hop will do.'
And all night long, he sings this song, in a tunnel at No. 2:
'You never hittee the pipe before, Two-bittee hop will do.'"

The popular song writer sings, "Dreamy, Dreamy Chinatown, Where the Lights are Burning Low."

The writer of more dignified lyrics pens, "In the Garden of Sleep, Where Poppies are Born." This, of course, is a symbolical lyric, but it suggests the poppy sleep and the dreams which Freud had not yet classified. From the pocket of an addict we took a bunch of verses. Four lines from a long poem, describing the delights of early addiction read:

"Oh, Dr. Simon tell me true,
What did I ever do to you?
You passed a law that took my dope away
Give it back to me, I pray."

Jack Boyle, a wonderful writer, has given us, "The Poppy Girl's Husband." Motion picture literature is full of knock-down and drag-out drug stuff; and so addiction has produced a literature, but the drug literature that New York's Police Commissioner Richard E. Enright is interested in, is, "Written in the Statute Books."

The Commissioner is a far-sighted man. Not because he appointed me, but because he realized the heavy inroads the narcotic evil was making and the close connection between addiction and crime. I regard him as a 100 per cent police commissioner.

When drug addicts in the United States had reached the startling total of 1,988,000, quoting from the figure of Representative Rainey, of Illinois, Commissioner Enright decided on drastic measures. He realized that 60 per cent of addicts were criminals with records, in some instances, reaching from Vancouver to New York. Then he asked me in to help clear the situation.

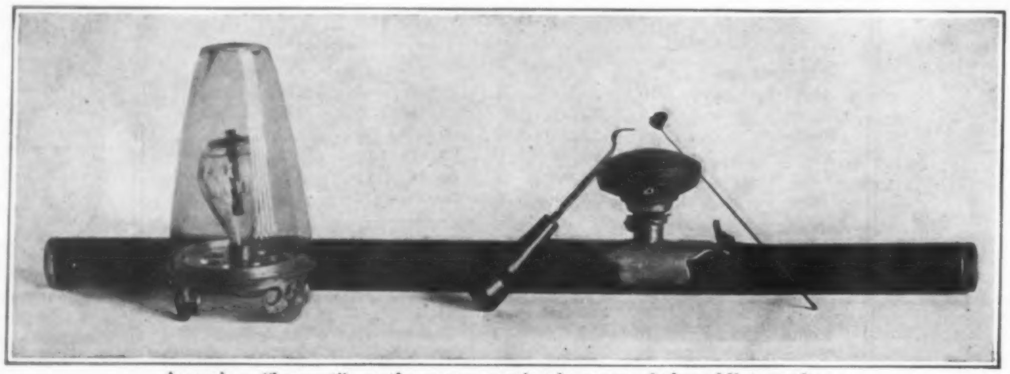
With my knowledge of drug addiction and underworld information acquired as an expert for the New York State Narcotic Commission, and extensive experience of a life devoted to the study of psychology and criminology, I considered it my patriotic duty to help crush this evil. No financial gain or political ambition is involved in our crusade against drug bondage and its many ramifications.

From the standpoint of the police, all the romance of the songs and short stories is swept away on the fumes of a drug which brings depletion, depression, poverty, despair, crime and death, and only a world war waged night and day keeps this scourge from sweeping humanity to hell. It *is* a world war, for I have secret mission men in Europe and the Orient, and have a close cooperative understanding and a system of information with practically all important cities in Europe and America. We have, now at Police Headquarters, the first and largest clearing house in the world on the drug traffic and drug addiction. We can furnish on short notice pictures and records of almost any known addict, smuggler or vendor in any city. We have pictures and records sent us from the governments of France, Belgium and Canada, and reports by which we can feel daily the pulse of the activity of this evil.

Not only in the hovels of the great East Side of New York and the slums of other cities is this reason-dethroning, death-dealing habit found, but in the mansions of the rich as well. It is a spreading fire that has to be fought with fire. I have in my personal possession a list of more than 100 prominent New York addicts. Among them are artists, theatrical people, writers, and at least one millionaire. Some are innocent victims; others have sought excitement and sensation, and go to the slums for their supply.

The drugs most used are: Gum opium and its derivatives, including codeine, paregoric, morphine, heroin; cocaine, a crystalline alkaloid, derived from the leaf of the cocoa plant; and the latest, hash eesh, derived from the Indian hemp, *Cannibas Indica*.

From hash eesh, significantly enough, we derive our word assassin. This drug only recently has found its way into the United States, being smuggled by Turks and East Indians. It is not prohibited by the Harrison Federal Narcotic Law. The only law covering it is the new Sanitary Code Law of New York City, under which our department now operates, and without question, this law will be added to the Federal Law. It is no crime to possess, sell or use this terrible drug anywhere outside of New York City—for the time being, at least.

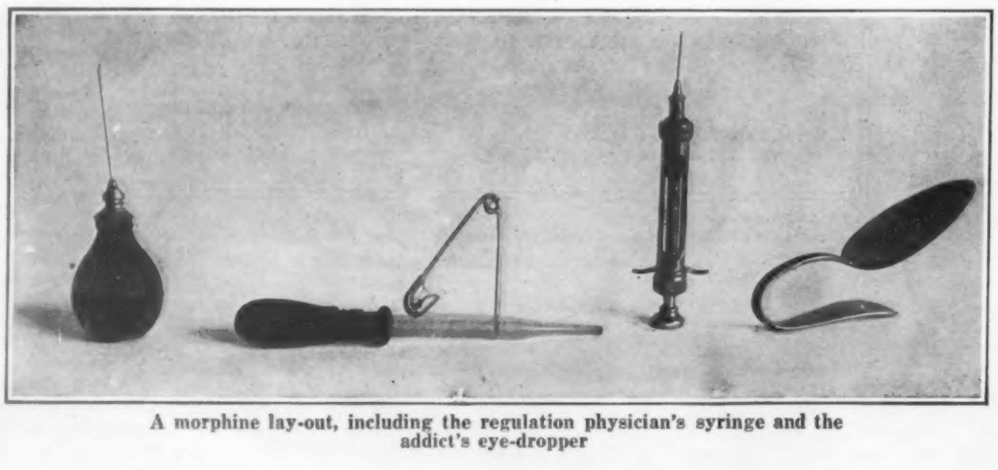


An opium "lay-out", or the necessary implements of the addict smoker

Addicts' methods of taking drugs are divers. Cocaine and heroin are usually snuffed. Morphine is taken by hypodermic needle, or in the absence of a needle, an eye-dropper is used. The common method of using opium is smoking, and this is an intricate process, requiring experience. The gum opium has to be especially prepared. The gum is picked up in a "pill" about the size of a large raisin. It is placed on a tool resembling a darning needle, and called a "yen hock" (Chinese). With this implement it is rolled on a hot pipe bowl held over a peanut oil lamp and "chied" (Chinese for cooked). When chied the pill is pressed down hot over the small hole in the bowl, and the addict lying on hip, throughout the cooking and smoking process, holds the pipe over the lamp and, with a "long draw," inhales the fumes deep into the lungs.

There is no form of drug using so luxuriant as is smoking "hop" (Chinese for opium).

It remained for a drug addict to call attention to the fact that a fluid may be expressed under the skin by a puncture and pressure. The usual form of self-administering morphine by a street addict is to make a puncture in the skin with a safety-pin. An ordinary eye-dropper is then filled with solution and pressed against the puncture, the fluid being slowly forced under the dermis. Anyone who has never before seen this novel method employed marvels at the ease and rapidity of the injection. This idea, without question, results from the cheapness and ease in procuring the ordinary eye-dropper and was adopted also to avoid laws regulating the possession of hypodermic syringe and needle.



A morphine lay-out, including the regulation physician's syringe and the addict's eye-dropper

To stamp out the use, the smuggling and selling of drugs, my entire division work from fifteen to twenty hours a day. When I first took charge, the force worked all at one time. This left many hours uncovered. I arranged schedules so there is a force covering the

city, including the water-front, day and night. I divided the force into four sections:

Section 1. Older and more experienced men, qualified to prepare and handle cases in court.

Section 2. Looks after street vendors, buyers and addicts.

Section 3. This is the most interesting, for it is the mysterious section—the source of underground information—all types of people who delve into the very heart of New York, into the boudoirs of fair ladies, into the dressing rooms of theatrical stars and among the leisure classes, where unrestricted vice may be maintained secretly in an atmosphere of supposed refinement.

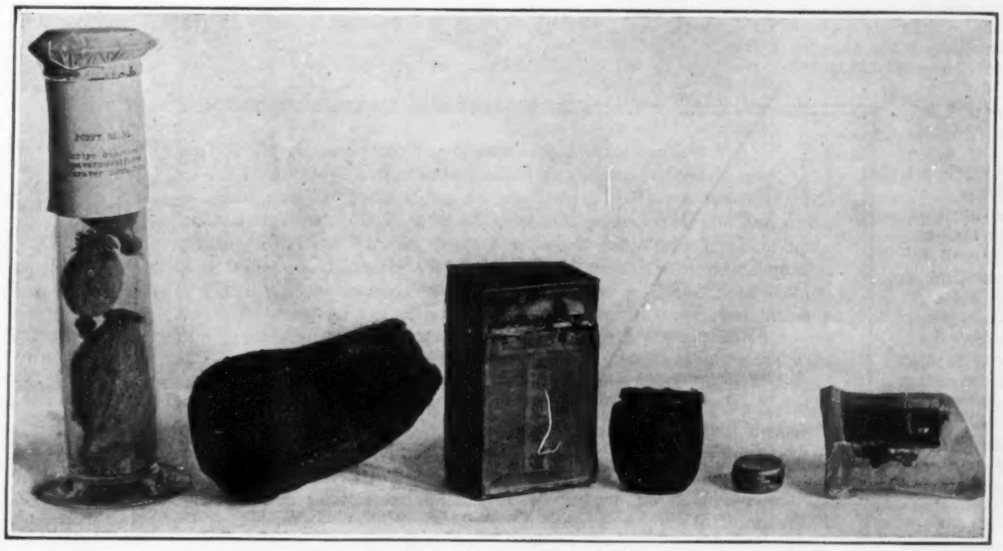
Some of these secret agents delve into the lower social sub-strata and into criminal life—the degenerate denizens of the underworld, whose condition as social outcasts is rendered more helpless, hopeless and pitiable because of their slavery to drugs. Many of these secret agents never appear at headquarters and are known only by numbers. We aim to detect every drug user. We have spies everywhere and are proud of it.

Section 4. The marine section, covers most of the water-front, docks, piers and ships at anchor.

Smugglers, importers, vendors—all deal in illicit drugs for the same reason that they bootleg whiskey—for profit. I know of no criminal endeavor that brings quicker or larger profits. Adulterated for street sales, the profit on drugs is about 900 per cent. If the drug happens to be smuggled from Germany, you can add increased profits due to the rate of exchange of dollars for German marks.

Drugs for pleasure began so far back we can hardly trace the origin. We have traced the connection between crime and drugs back to the tenth century when certain tribal rulers used narcotics to incite subjects to murder.

I have definitely established the fact that there is a wealthy drug ring in Germany which vies for drug addict sales and world supremacy in this trade with Japanese distributors. Before the Harrison Law was passed the opium importation into this country, legitimate and illegitimate, was around 1,000,000 pounds or Chinese "funs" annually. It is hardly possible to compute it at present, because smuggled importations are so carefully hidden. Drugs come in from Mexico, Canada, Eastern and Western Coast ports, from South America, Europe and the Orient.



Opium from the poppy pod to the final retail package called a "deck"

All the opium needed for legitimate use could be raised in California. All the cocaine needed for surgery is a small part of what is used to add zest to sensation-craving lives.

The "movie" thriller does not exaggerate. One of our men, a brave, efficient young fellow, died from the effects of a kick administered by an addict in a raid. Cornered in a rooming house in Brooklyn, my men had a running gun fight, up and down stairs, into the basement and round about, with Spanish drug smugglers. One of the smugglers was shot dead, after a chair had been thrown through a window by one of our detectives to attract the attention of a waiting squad outside.

There is little drug addiction in China. The law is too severe. Our smugglers are Italian, German, Japanese and Spanish.

Almost every ship for a time carried some narcotic drugs. They have been found hidden in false bulkheads, coal bunkers and in a hundred different cleverly concealed caches. Chief engineers and other ship's officers and men have been corrupted by this smuggling ring and have been arrested by us. Individual smugglers have concealed drugs in shipments of olive oil and other freight, in children's hair, in heels, tongues and linings of shoes, in cartridge belts, and in a myriad of different ways.

Reason for the increase in drug addiction lies in the fact that an individual who takes drugs for a short period becomes an absolute slave to a demand which once created cannot be denied. This baneful influence becomes the greatest curse of civilization. The individual must have his drug. He has released a monster that must be appeased, that moral education, love of home or the best of intentions cannot hold in control.

Men who hold responsible positions, when they become addicted neglect their business. Their efficiency runs down the scale to inefficiency and they lose their positions. Gradually more of the drug must be taken to satisfy. The higher moral faculties, slowly but surely, are obliterated. The addict cannot work. Money must be obtained. They pawn their valuables and those of their relatives. Their household goods follow. The demand must be satisfied. The cost of their daily supply mounts from two or three dollars to from \$10 to \$15.

They have no way of getting this daily "dope" tax legitimately, and so they enter criminal life, and—many die from overdosage—others indirectly from malnutrition.

We draw a strong line of demarkation between the street or criminal addict, and the patient in care of a physician. We do not molest any reputable physician in the legitimate practice of his profession, or the poor unfortunate who is suffering from a disease and who requires alleviation from his pain. In the interest of humanity, the criminal addict, the street vendor, and the smuggler must go.

A Photographic Innovation

PHOTOGRAPHERS have long desired to find a method which would enable them to develop negatives without the exclusive use of the dark room, since because of the dim light therein it is often difficult to judge whether the plates have reached exactly the right degree of development, and they are only too familiar with the fact that neither an undeveloped nor an overdeveloped negative yields the best results in the finished picture. This desire has become even more urgent because of the recent progress in the art of taking photographs in natural colors. A German inventor, Dr. Lüppo-Cramer, is one of the most recent claimants of the honor of devising such a process. The process in question is known as the "Safranin Process," and it is described by the inventor himself in *Die Umschau* (Frankfort) for March 19, 1921.

The new process is very simple, requiring for its operation merely a suitable amount of the red dyestuff known as *phenosafrainin*. A solution of this substance is made in ordinary water in the proportion of 1:2,000, and 10 cubic centimeters of this solution are then added to every 100 cubic centimeters of the ordinary developing solution. Since the developing solutions have no influence upon the dyestuff, a larger supply than needed of the mixture can be prepared and kept in stock for the sake of convenience.

Developing solutions thus prepared have a very clear red color so that every detail of the picture can be observed with the greatest convenience and accuracy. Dr. Lüppo-Cramer makes the following remarks respecting the application of his process:

"The operator must take care to leave the plates for one minute in the red colored developing solution before exposing them to yellow light, so that the dyestuff will have time thoroughly to penetrate the sensitive film and make the latter non-sensitive to yellow light. I, myself, make use of a five-candle lamp enclosed by a very bright yellow shade; the development is complete within 1 and ½ minutes directly under the light of this lamp, no further precaution than that stated above being necessary. The course of the development is perfectly normal. Even from the most highly sensitive plates, provided, of course, that the exposure has been properly made, one obtains crystal clear pictures, even in cases where control plates, which have been developed without the addition of the pheno-safranin are entirely clouded.

"After being developed the plates have a reddish tone not unlike that of the ortho-chromatic plates of commerce, but this red tint readily and completely disappears after the fixation and washing of the picture."

Since the protective effect of the solution does not depend upon immersion in the latter but is due to a chemical action of the pheno-safranin upon the silver bromide, the plate can be removed from the development from time to time and observed under the bright lamp light without risking clouding it."

Ortho-chromatic plates can also be developed in this manner under yellow light. Dr. Lüppo-Cramer continues:

"My process can be used to great advantage also in the case of pan-chromatic plates and of those which are sensitive to red light. Of course, in such cases, the lessening of the sensitiveness through the presence of pheno-safranin in the developer is not sufficient to permit of the use of yellow light. But very bright red light which will cause the plates to be badly clouded in an ordinary developer, can be used without difficulty in the presence of the pheno-safranin."

While thus far we have considered a very brief use of the dark room and yellow light instead of pure white-light, the inventor gives further directions by means of which both of these can be dispensed with when to do so is convenient as during travel.

He says: "By observing the following directions the most highly sensitive plates, including those sensitive to color, can be developed entirely without the use of a dark room by *ordinary candle light*. The operator must immerse the exposed plate for one minute in a 1:2,000 pheno-safranin solution, the light being, meanwhile, entirely excluded; he then lights his candle which should be placed at a distance of 1 and ½ meters (about 5 feet), after which the plate is taken out of the dye solution and placed in an ordinary development, from which an entirely unclouded negative will be secured."

Dr. Lüppo-Cramer closes his article by a brief mention of a new and important field of application for the desensitizer discovered by him. Since X-rays remain practically undisturbed by the dyestuff in the sensitive film, plates intended for the taking of X-ray pictures can be previously impregnated by a suitable desensitizer and put on the market ready to use. Plates of this sort can be unpacked under a yellow light, placed in the plate carrier and developed without any previous manipulation. (The inventor has applied for a patent on his process of desensitizing X-ray plates.)

Colors of Antiquity

IN the Division of Dye Chemistry of the American Chemical Society at its recent meeting, Dr. J. Merritt Matthews gave as his opinion that the fast colors of antiquity were not so much due to the better dyes employed but to the fact that in the application of these dyes a great deal more care was exercised and a great deal more time taken. In the discussion it was pointed out that advances in economy in the application of dyes can easily be accompanied by a deterioration in quality which emphasizes again the point often made that American-made dyes themselves are not so much open to criticism as methods used in their application. It has been pointed out also that methods are not apt to improve under present conditions when the price of fuel is such as to tend to shorten every process where heat is employed, such as, for example, the proper steaming of printed goods following the application of dye. One observer has said that the requirements of organized labor are such that the time of the men engaged in the work is shortened as much as possible. So long as these and similar conditions obtain it can hardly be expected that improvements can be made in the dyestuffs themselves which will altogether make up for deficiency in their proper use.

What Do You Know?

The Edison Questionaire—Its Aim, Its Results, and Its Collateral Significance

As Told by Mr. Edison to the Editor of the Scientific American

WHEN the newspapers first announced that Thomas A. Edison was trying out candidates for executive positions by setting before them a list of 150 questions on all sorts of subjects, none of which had any direct connection with the work the men would be called upon to do if employed, there were many to scoff. The amount of information a man has in his head on general topics, the number of isolated facts which he can produce from the recesses of his memory in a given time, were stated to have no possible bearing upon his fitness for executive work. Mr. Edison, in the face of biting criticism as well as misdirected endorsement, went right on subjecting his applicants to his questionaire, and putting to work the men who made the best showings. Enough time has elapsed for him to make now the unqualified statement that the results have justified this unusual mode of selection. Mr. Edison accordingly has been prevailed upon to tell, for this issue of the Scientific American, just what his idea was in setting these questions and why it has worked out so well. The article on these pages is the result of three conversations with Mr. Edison, and contains the first authorized quotation in extenso of questions from his questionaires.—THE EDITOR.

PSYCHOLOGISTS today are vastly concerned with finding the right man for the job and the right job for the man. So far as they have to do with selecting men for mechanical work, their methods are well developed, definite, satisfactory in their results. But when it comes to picking brain workers the situation is different. It is not so easy to set a man's brain to work before your eyes and watch it function as it is to check up on his fingers. Procedure for the selection of executive workers is still chaotic, still leads to no definitely satisfactory or systematic results.

Yet it is here that the need is most keenly felt for testing a man's ability without actually putting him to work. If we select the wrong man to turn crankshafts, the loss is limited to the number of crankshafts he can spoil before we find him out. Such a loss may be heavy, but it *is* limited. The loss that may be caused by a weak executive is, on the other hand, quite without limit. Mr. Edison says that single mistakes of minor executives have cost him as much as \$5000, and where it can be as bad as that he is lucky if it has not been worse. For let it be remembered, it is harder to locate a weakness in the executive force than one in the shop.

Mr. Edison has found out all this to his loss. "It costs too much," he says, "to learn whether a man is a good executive by trying him out on the job. So I made up my mind that we should have to have a formal test of some sort. This brought up the question of what we should look for; what is the most important qualification for an executive?

"When I call upon one of my men for a decision, I want it right away. When his department calls upon him for a decision, it wants it right away. It's all very well to say that you have got to look up the data on which the decision will be based, that you know just where to look, that data and decision will be forthcoming tomorrow afternoon. But I want the decision now; the department wants it now. It isn't convenient for me to wait, and certainly it isn't convenient for a whole department to hang in the air for an indeterminate period waiting for an executive to find something out that he might have had right in his head. My business is just like any other; when a decision is called for it must be forthcoming. And the man who is to make it must have all the pertinent facts.

"On this ground it seemed to me that the very first thing an executive must have is a fine memory. I asked myself if I had ever heard of a high-class executive who lacked this qualification. I hadn't; have you? Of course you haven't. So I determined that I should test all candidates for executive positions by learning what I could about their memories.

"Don't misunderstand me. Of course it does not follow that a man with a fine memory is necessarily a fine executive. He might have a wonderful memory and be an awful chump in the bargain. But if he has the memory he has the first qualification, and if he has not the memory he lacks the first qualification and nothing else matters. Even if after passing the memory test he turns out to be a failure and has to go, much motion and expense will have been saved by the immediate elimination of all candidates who lack this first requisite of memory.

"The questionaire that has attracted so much attention and been the target of much criticism was got up on this basis. The only way I know to test a man's memory is to find out how much he has remembered and how much he has forgotten. Of course I don't care directly whether a man knows the capital of Nevada, or the source of mahogany, or the location of Timbuctoo. Of course I don't care whether he knows who Desmoulins and Pascal and Kit Carson were. But if he ever knew any of these things and doesn't know them now, I *do* very much care about that in connection with giving him a job. For the assumption is that if he has forgotten these things he will forget something else that has direct bearing on his job.

"This memory of ours works in two ways. The things that are always before you, that you are continually conscious of knowing, comprise an insignificant part of the contents of your mental warehouse. Every moment of your life from the time you were old enough to perceive things at all, facts and facts and more facts have been sifting into your mind through the things you see and the things you hear and above all through the things you read—through your every contact with the external world. Millions and millions of facts which have come into your mind in this way ought still to be there. They stay down under the surface until you call for them—then if you have a good memory you find them popping right out. A man with a really fine memory of this type will often surprise himself by remembering a lot of things which he would not have supposed he had ever known, and which he can't for the life of him imagine how or when or where he learned.

"If I tell you something now, and you know that I am going to ask you about it tomorrow and that it is going to be important for you to know, you are a poor creature indeed if you can't make yourself remember it. If I tell you something that interests you exceedingly, it is mighty strange if that doesn't stick, too. But that is not the kind of memory that counts. Don't come here for a job and tell me that you can remember anything you want to, anything you consider worth remembering. Out of every thousand facts that present themselves to you, I should think that at least 990 come unobtrusively, without the slightest indication whether they are to be of any subsequent importance to you or not. If your memory is a success, it will reproduce—within the proper limits of human fallibility, of course—any one of these items, when and where you want it.

"Of course if I ask you 150 questions at random, I am going to strike some low spots in your knowledge. I am going to ask you some things that you never have known at all. No two people have precisely the same background of facts. But I do not expect anybody to answer every one of my questions. They are selected with the thought that they shall deal with things taught in schools and colleges—things that we have all had opportunity to learn, facts to which we have all been exposed during the course of our education and by our ordinary reading. Their subject matter is of no importance—they must merely be things that my applicants may fairly be assumed to have been taught at some time. Everybody must necessarily have been exposed to a very large majority of them. But if any candidate should answer every question on his paper, I should want to know where he got his advance copy of the questions! I am not looking for 100 per cent grades; but I am looking for, and I think I am entitled to expect, 90 per cent grades. A man who has not got 90 per cent of these facts at his command is deficient either in memory, as discussed already, or in the power of acquiring facts, as I shall presently make clear. And either deficiency is fatal for my purposes."

Mr. Edison's insistence upon memory as the object *par excellence* of his test surprised me. I had revolved the questionaire in my own mind, and had succeeded in justifying it on a somewhat different basis. It had seemed to me that it was reasonable to insist that men going into the employ of the Edison industries, or of any industry of similar scope, be all-around men of parts; and that the questionaire afforded a means of determining whether they were so, or whether their interests were so narrow that they had not taken the trouble to pick up the general knowledge of the world about them which they ought to have. But Mr. Edison made me see that this was not the point at all. Unquestionably, if he is sufficiently educated to hold down an Edison job, the man has been exposed to practically all of the facts called for by the questions. It is then not at all a matter of whether he has been sufficiently interested in them to retain them deliberately; it is merely a question of whether he possesses the automatic memory that retains them anyhow. If he has, as Mr. Edison says, he has satisfied the first requisite for an executive.

Mr. Edison has a little anecdote illustrating this point admirably. One of his foremen, passing through the shop under the eye of an inspector—a man who was hired on the basis of his A grade on the questionaire—walked directly past two men who were sleeping at their benches. He apparently looked at them, but they made no impression on him—he didn't see them. He was maneuvered about so as to pass them again; again his attention was not attracted by them. This is where, in Mr. Edison's estimation, the side of the picture opposed to mere memory comes in. You can't expect a man to retain what he has not taken in at all. And there was obviously an impediment between this man's organs of sight and his perceptions of things seen. He would be likely to fail in the questionaire test through not having put his facts, in the first instance, in a secure enough place in the mental warehouse; through the same atrophy of the observational faculty he would be certain to fail repeatedly in the proper discharge of his executive functions.

"Somewhere between the ages of eleven and fifteen the average child begins to suffer from this atrophy, this paralysis of curiosity, this suspension of the power to observe. The trouble I should judge to lie with the schools, but its precise seat I would not venture to suggest. Perhaps it lies in a flagging interest, which leads quickly to the habit of listening without hearing, of looking without seeing—a habit which once fixed persists without regard to the existence or non-existence of interest. Whatever it is, it is clear to me that our schools and colleges are turning out men who not merely have failed to learn, but have been robbed of the capacity to learn."

Lest it appear that Mr. Edison exaggerates the conditions, I prevailed upon him to permit me to examine in detail a considerable number of the more unsatisfactory answer papers from a questionaire that was set some months ago. I eliminated from consideration all men who were not indisputably college graduates. This left in my hands a considerable number of papers written by men who had gone clear through a university or college of rank, and had emerged with a degree. Practically all of them had, in addition, employment records justifying them in applying for a minor engineering job with prospects of promotion. I abstract some of the things these men knew that are not so.

Pittsburgh is 70 miles from New York; also 150 and 160. The distance from St. Paul to Minneapolis is anything you please up to a maximum of 250 miles; and those who know them for twin cities place them abreast one another, on opposite banks of the river.

Tierra del Fuego is in Mexico and it is in Spain. The Selkirk Mountains are in Sweden, Dakota, Tennessee, Scotland, Spain. The Wyoming Valley is placed by general consent in Wyoming. Kamchatka is a mountain in Japan. It is also "in the Adirondacks." Albuquerque is in Louisiana, in Canada, and in French Africa. The capital of Maine is given as Portland and as Bangor, which might have been expected; and as Bengal! Two candidates have the rock of Gibraltar on their right as they enter the Mediterranean. Khartum gravitates between China, India and Persia. Pamlico Sound is on Long Island, in Nova Scotia, and in the

place where we have always supposed Puget Sound to be. To make up for this we find Cape Race in Virginia, in North Carolina, and in "southeastern South America." Montauk Point appears in Maine, in Connecticut, in Nova Scotia. The Gobi desert is in New Mexico and Arizona, but the earth's equilibrium is preserved by the presence of the Painted Desert in Asia and in Africa. The leading city of Newfoundland is Halifax (three votes), Vancouver, Sydney—and Nova Scotia again!

Camille Desmoulins is identified as painter and writer, as author and dramatist, as plain author, and as actor. Count Rumford "invented the baking powder that bears his name." One candidate took a chance on Machiavelli and described him as an artist; another man took a chance and reported him a painter and sculptor; a third conservative soul refused to take any chance at all and identified him as "an Italian." Plenty of men described James Watt as the inventor of the electrical unit that carries his name. Lord Kelvin was a distinguished economist and parliamentarian, and he invented the compass. Isabella's partner on the throne of Spain is given as Philip and as Alphonso (without any numeral). The wife of Napoleon III. is given as Marie Antoinette and as "Helen": Helen of Troy, no doubt. In reply to the specific question, "What king of Egypt built the great pyramid?" we are told Pharaoh and Pharoah and Pharoh and Rameses and Ramasus, all of which I suppose might have been expected; then we are told Alexander, and we are told Archimedes! Genghis Khan appears to have had a checkered career as a Chinese Emperor, an "Indian character," a Turkish general, a philosopher of the same race, and the head of the Hungarian Soviet. The author of Robinson Crusoe was Robert Louis Stephenson, and Balzac was a Brazilian patriot.

There is a pronounced consensus of opinion that the capital of Bulgaria is Budapest with a small *p*; dissenting reports are filed in favor of Bucharest and Belgrade.

Asbestos is a compound of magnesia and it is a product of blast furnace slag. The atmospheric pressure is usually given correctly, but it appears in one paper as 70 pounds and in another as 776. Graphite is "the mineral base for making lead." Menhaden is a bay. The liquid used in fire extinguishers is carbon dioxide. Three candidates knew pepsin only as a flavoring, and one of them tells us it is got "from the tree of the same name." Forty per cent in favor of starboard as left seems pretty high. 606 is a war gas, and it is a washing powder. The geometric lathe is an instrument to measure the area of triangles.

Nothing could be easier than to name three leguminous plants: cabbage, lettuce and spinach. A second authority substitutes turnips for spinach, giving the same list otherwise. Conifers are described as trees that "bear fruit yearly"; as "broad-leaved trees"; as "trees like cypress and birch." If we had this chap up for oral examination we might learn why he groups these particular two instead of the crabapple and the weeping willow. Asked to name eight fruit trees, several men stopped at six; one made the grade by including the grape, and another the blackberry.

Great diversity of opinion exists with regard to the prevalent beast of burden in the Andes. The mule has a plurality, hard pressed by the goat. The donkey receives honorable mention. There are two votes for the "lima" and one for the "alpecka."

The number of feet in a fathom varies from 5 through 27 and 30 and up to 5400. Asked to guess the freight on a carload of oranges from southern California to Chicago, the candidates give figures running all the way from $20 to $2000.

Where is metallic aluminum obtained? One man, determined not to go wrong, tells us "from aluminum ore." Asked to name ten different metals in commercial use, one man ran down at nine, one at seven, and one actually at five. Coal was included in one list, and one man named both steel and iron. Amber is described as a hard wood; and five men try to play safe by characterizing it simply as "a substance."

The function of baking powder is given as the sweetening of the bread by preventing acidity and alkalinity, and (by two men) as the rendering of the bread more digestible. Another candidate reasoned that if the active principle of coffee is caffein, that of tea ought in all fairness to be taffein. A very respectable majority of the candidates whose papers I saw replied to the good old chestnut "Why can't you boil eggs on the summit of Pike's Peak?" with the explanation that the low atmospheric pressure raises the boiling point of water to an unattainable height. Another informs us it is because the proximity of the sun causes great heat.

The cause of the moon's phase is the tides. Several men differ from this, insisting that it is the earth getting between the sun and the moon.

Mr. Edison discussed the possible significance of all this at considerable length. On some phases of the matter he has very firm convictions; on others he is less decided or not at all. One angle on which we agreed thoroughly was that the low standards maintained in our schools and colleges have much to do with the phenomenon that has manifested itself in these questionaires. Mr. Edison made a point here.

"If I had a man in my employ who was right only half the time, or a little more than half the time, he would last just about long enough for me to find him out—and that would not take very long. But our schools consistently and persistently give passing grades to students who are right a bare 60 per cent of the time. I consider this a disgraceful procedure. If they can't teach the boys and girls to be right more consistently than that it is about time they admitted their failure and gave up the effort to teach them at all. In the good old days when a student had to be right practically all the time or take a caning and occupy a position of general disgrace, the school and the college produced far better results. I consider that a man who makes a grade of 50 on one of my tests has scored a total failure. Anybody who is not an imbecile ought to answer half my questions. It is after he has answered half and has started on the second half that the candidate should begin to find himself in some difficulty. Just looking at it in the superficial way, the way the schools look at it, the man who grades 70 is 20 points better than the man who grades 50; the man who grades 90 is 40 points better than the 50 man. But if we realize that 50 is the absolute minimum, and score on the basis of the candidate's performance with his second 50, the man who makes a grade of 70 has really accomplished 40 per cent of what we have set before him, and the man who gets as high as 90 has answered 80 per cent of the questions above the practical zero. There is a lot more difference between 40 and 80 or between 0 and 40 than there is, respectively, between 70 and 90, or between 50 and 70. I have not the slightest use for a candidate who scales below 70—that is to say, who does less than 40 per cent of what I would hope that he might do. The 70 man I consider poor picking. It's the man who makes a grade of 90, which is just twice as good as the weak brother's 70, to whom I give serious attention.

"If our schools would stiffen their standards, and find a means of holding the intellectually lazy average student of the present day to these stiffened standards, we should find, I think, that the system of learning today and forgetting permanently tomorrow would go out of fashion. If the set, formal examination were given less prominence I should think that would help too. A student must be of low caliber indeed if, with printed text and written notes before him covering the entire work of the term, he cannot cram enough facts into his head and keep them there long enough to get past the examination. When he has done this, so far as his present state of mind is concerned, he seems to be through with those facts—finished; he is never going to want them again, or worry about them. The habit of forgetting, the habit of not even taking things into his consciousness except under certain extraordinary conditions, is a vicious and a subtle one which he is not able to shake off.

"I am not a schoolman; I do not propose to attempt a solution of the school problem. But the results of these questionaires make it entirely clear that the problem exists, as I have stated it. Of the first 718 men who attempted my questionaire, only 57 could be given the grade of 70 which, after being revised to a practical 40, means nothing but 'fair.' Only 32 attained a mark approaching 90, enabling me to see where they had done four-fifths of what was set before them to do, and earning a grade of A."

No test, of course, is of value on its own grounds alone. The correlation must be shown to exist between the thing for which we are looking and the thing which we find. In plain ordinary language, the test must work. I interrogated Mr. Edison on this aspect of the case, and he was enthusiastic.

As fast as he finds them he takes his A men into his factory for training as executives. And they all turn out to be first-class executives. When he runs out of A men he is sometimes tempted to step down, and try out some B men. And they turn out to make very poor executives. That ought to settle it.

Mr. Edison is not at all blind to the fact that his procedure has side-lights far removed from the main aim of testing memory. Some of these lend strength, some perhaps involve elements of weakness. One little item in which he is greatly interested is the ability of the candidates to read his questions accurately. One of his earlier questionaires contained the question: "What was the name of the wife of Napoleon III.?" A disgracefully large proportion of the candidates stopped reading this question when they struck the familiar word "Napoleon," and answered "Josephine" or "Marie Louise." The inventor regards this as further demonstration of his belief that the sense which makes for assimilation of the things presented by the external world is atrophied. He also traces a connection between the careful reading of the question that leads to a correct reply, and the engineering instinct for identifying all the significant details of a problem and attaching to each its true weight.

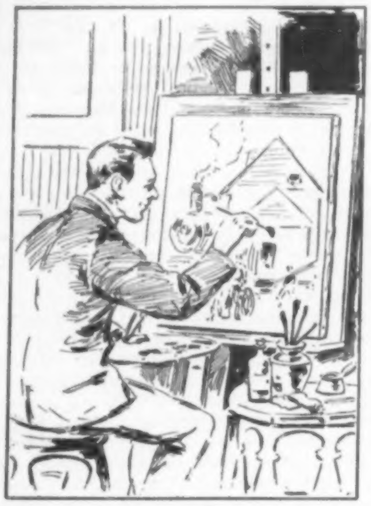
That this failure to read understandingly is far from rare a few more quotations from answer papers may make clear. The mediocre man is utterly unable to establish the proper connections between his mind and the externals. When we ask him "What are the active principles of tea and of coffee?" he replies "They are mild stimulants," or "The soothing effect on the nerves," or "The extraction of the flavoring by means of dissolving in hot liquid." He includes a surety company and a national bank in his list of three prominent trust companies; to the question "How is sheet iron coated with tin?" he replies "To prevent corrosion."

One encouraging feature of this questionaire business is to be noted. The college men, taken as a class, are bad enough. But they are so much better than the men who have not had any college that Mr. Edison has practically made the college education a prerequisite for positions of the sort to which these questionaires lead. Mr. Edison can see where the colleges have failed measurably; but their failure shines like success in comparison with the failure of the schools beneath them. The colleges apparently teach their students, at least to some extent, how to read; for the questionaires indicate rather clearly that the facts picked up by college men in the ordinary reading of book and newspaper stick fastest.

On the other hand, a new feature introduced into the questionaires only a few days before I talked with Mr. Edison brings out an altogether discouraging result. To learn whether there are men who possess the mastery of process and the ability to reason while lacking the background of facts, Mr. Edison included in the current questionaire five numerical problems that required merely the ability to reason and to handle elementary arithmetic. He had his examiners report on these five questions separately from the bulk of the paper. I cannot quote the questions because they are still "alive." But I can assure my readers that it would be a disgrace for any grammar school graduate to fail on three of them, for any high school man to miss the fourth, and for anybody in the world to fall down on the fifth.

Yet the results of these five questions were quite poor enough to justify any generalizations which Mr. Edison might make about the inability of the college man to use his brain. That they did not call for a specialized type of mind is indicated by the fact that the showings of the candidates on the five questions were strictly in proportion to their showings on the other 145. Many of the answers were wrong in such a fashion that the slightest degree of thought would have made evident their absurdity and their inconsistence with the terms of the question. If an engineering graduate with engineering experience can't do simple arithmetic, Mr. Edison seems justified in demanding to be shown what earthly use there is for him.

DO you believe that Balzac was a Brazilian patriot? Do you believe that Kamchatka is in the Adirondacks? Do you believe that Genghis Khan was the head of the Hungarian Soviet? Do you believe that Lord Kelvin invented the compass? Do you believe that the Egyptian king who built the great pyramid was Archimedes? Do you believe that the capital of Maine is Bengal? Do you believe that the reason you can't boil eggs on the summit of Pike's Peak is that the proximity of the sun makes it too hot? Do you believe that the cause of the moon's phases is the tides? Do you believe that blackberries grow on trees? Do you believe that the chief city of Newfoundland is Nova Scotia? Ninety per cent of the college men who apply for employment in the Edison industries believe these things and others things of the same degree of absurdity. Mr. Edison has in his office documentary proof of this statement. What is the matter with our colleges, and what are they going to do about it?



1.—Painting the original drawing in oils on canvas

2.—Photographing the original for the various colors

3.—Developing the negative plate in the darkroom

4.—Retouching and opaqueing the various negatives

From Easel to Cover

Offset Lithography as Applied to the Scientific American Covers

By Austin C. Lescarboura

THE artist of today has an unlimited audience. His art may become known to tens of thousands—even to millions upon millions of persons; yet, strangely enough, this very condition often means that his original paintings are seen by few persons aside from the craftsmen who process them from the master subject to the numerous reproductions. In fact, this is the age of commercial art, and by far the greater number of paintings today are made not so much with their actual appearance in mind as with their reproduction qualities. In a word, most of our present-day paintings are made to please the camera, so to speak.

A case in point is the SCIENTIFIC AMERICAN covers. The originals for all our cover illustrations are generally oil paintings on canvas, measuring 17 x 22 inches. Up till some four years ago the covers of this journal were printed by the process color method, on regular printing presses; but of late years the offset lithography process has been developed to such a point that there is no longer doubt about its superiority for faithful reproduction, especially in colors, and for rapid work. In fact, it is ideal for publishing purposes. Hence it is our purpose here to describe how our original oil paintings are reproduced on our covers, while the accompanying sketches depict the progressive steps of the process.

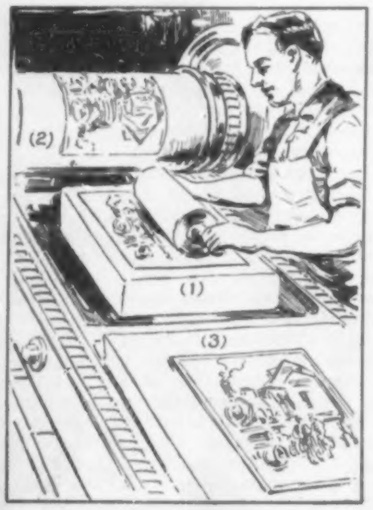
The original oil painting is the result of an idea originating in the editorial rooms. Sometimes the idea is due to a bit of current news, a clipping from a technical journal or Government report, or again a photograph or contribution. The idea is given to the artist, who works up a rough color sketch in order to show how the subject will work out. The rough sketch is generally subjected to a number of changes, both in composition and distribution of color. With these final data to go by, the artist transfers the details of the rough sketch on to a large canvas and works up the original painting with painstaking care, as shown in our first sketch.

The painting, after being approved with or without final changes, is now ready to be reproduced. The first step is the photographing of this original and the separation of the color values, which is shown in the second sketch. Anyone familiar with color photography knows that certain color filters cause certain colors to be filtered out while others are permitted to pass through and register on the negative in the camera. This is precisely the basis of color reproduction processes. The photographer places the original before the camera, illuminates it by means of powerful arc lamps, and carefully racks his camera back and forth until the proper sized image is obtained on the ground glass. Then he focuses the image as sharply as possible.

The original is now photographed with various color filters in order to separate the different colors and obtain a yellow, red, and blue negative—the three primary colors, and black. The black plate is necessary for a sharp, clean-cut reproduction. Do not misunderstand this statement: the negatives are not colored yellow, red, and blue; but they do contain the latent values of each of these colors, so that when they are printed on to sensitized metal plates and those plates are duly processed, they will render the correct values of their respective colors so as to produce a faithful reproduction of the original.

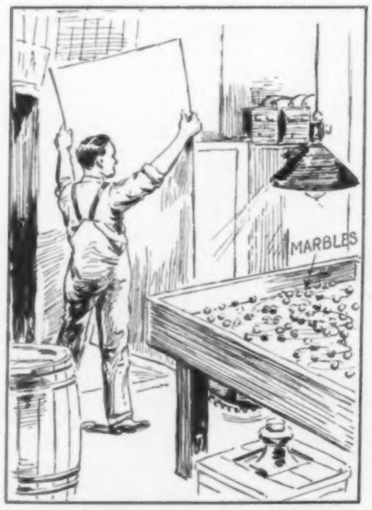
Wet plate negatives are employed in this photographic work, which is virtually identical to the photo-engraving process. The wet plates are simply large pieces of heavy glass coated with wet collodion carrying a relatively slow emulsion. That is to say, it is not very sensitive to light, as compared with the highly sensitive emulsions of dry plates and films. The image is not permitted to fall directly on the wet emulsion, but must pass through a fine screen as in the case of the usual half-tone plate making. This fine screen breaks up the image into a pattern of dots, with any desired degree of fineness, depending on the screen selected. Screens are identified by the number of lines to the linear inch, the greater the number of lines the finer the dot pattern.

Once the image is registered on the wet plate, the latter is removed in its plate holder to the dark room. Holding the negative plate by one corner, as shown in our third sketch, the photographer merely pours the developing solution on the wet collodion plate and manipulates the plate rapidly so as to spread the solution over the surface in an even coat. The image soon

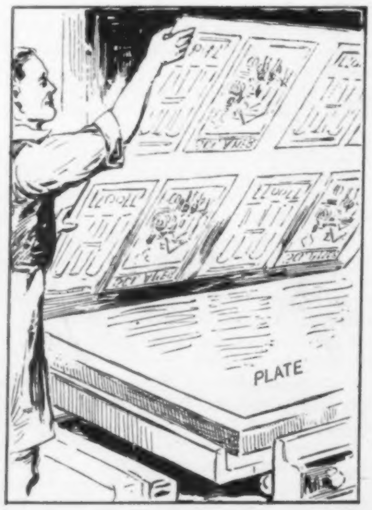


9.—Proving the zinc plates on a special offset proving press

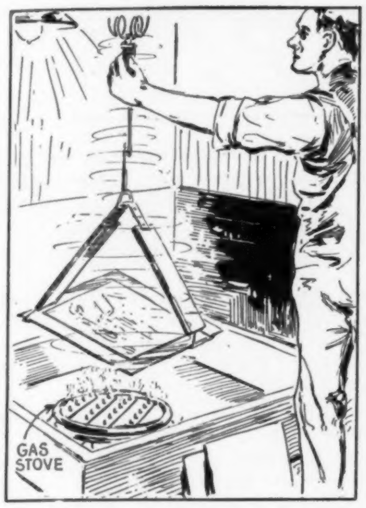
10.—Making the transfer sheets from the zinc plate original



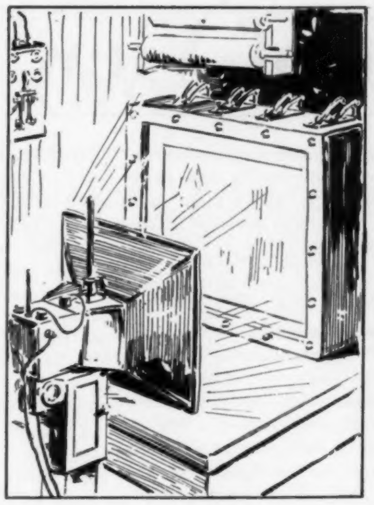
11.—Graining the aluminum plate by means of rolling marbles



12.—Laying the impressions in position on to the aluminum sheet



5.—Drying the sensitized zinc plate over gas stove



6.—Printing the negative image on to the sensitized zinc

7.—Rolling up the zinc plate image with heavy ink

8.—Etching the zinc plate image with acid-soaked brush

develops, after which the negative is fixed in the usual manner so as to remove the free silver and leave only the desired blacks and half-tone values.

As accurately as the camera does its work of reproducing the color values of the original painting, it is always necessary to retouch the various negatives in order to emphasize certain features and to subdue others. This work is done by expert retouchers and is known as opaqueing, shown in our fourth sketch. Certain parts of the negative which are not to be shown in the print are painted out with opaque ink, and others are strengthened the desired degree.

The next step is to prepare a zinc plate for each negative. The zinc plate is coated with a sensitizing solution and dried over a gas stove. In order to heat the plate evenly, it is held over a gas stove and twirled around quite rapidly by the simple arrangement shown in our fifth drawing. Once the zinc plates are ready, they are placed behind their respective negatives in a large printing frame and printed by means of the rays from a powerful arc lamp, as shown in our sixth sketch. Considerable pressure is brought to bear on the negative and zinc plate, and the heaviest kind of plate glass has to be employed in the printing frame.

With the image now transferred to the zinc plate, the latter is gone over with heavy ink. The ink is applied by means of a rubber roller, as shown in our seventh sketch. Successive applications of ink cause certain parts of the zinc plate to be heavily coated, while others remain untouched and clear. The zinc plate is now ready for etching. The acid etching solution is applied with a wide brush, as shown in our eighth sketch. The ink coating protects certain parts, while others are bare to the attacks of the acid. In this manner the image now becomes mechanically engraved on the zinc plate in a definite dot pattern.

At this stage it becomes possible to prove the offset plates, so as to make certain that the work is satisfactory. Indeed, the success or failure of an offset job depends primarily on the quality of the plates, hence it is well to prove them, in the parlance of the trade. For this purpose a miniature offset press is used.

Offset work, we may just as well say here, is, as its name implies, the printing of a plate by offsetting it on a rubber blank, which latter member then prints on the paper. Consider three cylinders revolving in mutual contact. The upper one is the plate, the middle is the rubber blanket, and the bottom is the paper. The impression on the plate is printed on the rubber blanket, dot for dot, just the same as the dots of the original plate. As the cylinder revolves the print or impression comes in contact with the paper, which is held to the pressure cylinder by means of a row of grippers similar to those used on the usual cylinder press. When the ink impression on the rubber blanket comes in contact with the paper each dot or line is pressed into the paper, whether it is rough or smooth, without smashing or spreading, but with clean, sharp impression.

Perhaps we are getting somewhat ahead of our story in describing the principles of the press work in offset lithography, but it is necessary to make clear what the workman is doing in the ninth sketch. The proving of plates follows the same general scheme as the press work. The zinc plate is placed at 1, on a stone block, and is carefully inked. The cylinder 2, covered with a rubber blanket, is rolled along and passes over the zinc plate, so as to receive the impression from the zinc plate. Rolling still farther along, the roller comes in contact with the piece of paper shown at 3, impressing the image on to the paper. Thus the zinc plate transfers its image on to the rubber blanket, which in turn transfers it to the paper. In the case of SCIENTIFIC AMERICAN covers, the zinc plate for each color is proved in turn, and great care is exercised so that the successive plates, inked with their respective inks, will be impressed on the same sheet of paper so as to give the final reproduction in full color. The care comes in registering the various plates so that their images will fall in the exact same space on the sheet of paper, making for perfect superimposition.

The colored proofs are submitted to the editors for their approval. Occasionally certain improvements may be suggested. Thus the colors may be too vivid, or the background may be too strong for the foreground, or the retouchers may have been too artistic in their efforts to strengthen the negatives. With the colored proofs once passed upon, the process moves on to what is called the transfer phase.

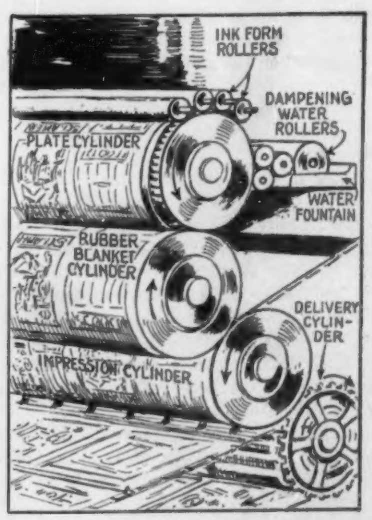
The method of duplication of a single plate on to the large plate from which the covers are actually printed is accomplished in the same way in which transfers are made for the stone lithographic process. It must be remembered that up till this time we have had but a single set of plates to deal with, and it is obvious that if a single set of plates were employed for the actual presswork, the time required would be considerable on an edition running into one hundred thousand and over. Hence it now becomes necessary to transfer the zinc plates on to another printing surface, and to obtain four sets of plates instead of one, so as to reduce the press work to one-fourth the running time. Each zinc plate is rolled up with ink, and the transferer pulls an impression direct from the zinc plate on to a sheet of India paper coated with a thin application of gum and glycerine, as shown in our tenth sketch. If four sets of plates are to be used for printing, four good proofs of each zinc plate must be pulled.

(Continued on page 80)

13.—Removing the transfer sheets from the aluminum sheet

14.—Etching the aluminum sheet by means of acid-soaked sponge

15.—Clamping the aluminum sheet on the roller of offset press



16.—General principle of the offset press and how it works

Our Point of View

The Aim of the Scientific American

DURING the St. Louis Exposition we met, personally, for the first time, a distinguished European physicist, who was engaged in pioneer work of a very special character. Modesty forbids our repeating in full the terms of praise in which he spoke of the SCIENTIFIC AMERICAN, which he had received and read for a long period. We had the curiosity to ask him why he gave so much attention to a journal which, because of its wide field, necessarily devoted but limited space to the special subject covered by his particular work. He replied that he valued it as a "scientific newspaper," which gave him a faithful record of all the more important developments in the broad field of science, and, so, kept him in constant touch with the world's progress in activities that lay outside his own. "You have not space for exhaustive treatment," he said, "but the digest and comment which you give are sufficiently comprehensive and so well chosen and directed as to give one a clear understanding of what is being done. I should think that, in addition to taking the paper which covers, in detail, his own particular field, every technologist would feel the need for that general information and comment which the SCIENTIFIC AMERICAN provides."

We quote the above tribute because it expressed, exactly, the aim and scope of the SCIENTIFIC AMERICAN WEEKLY. The MONTHLY, of which the present is the first issue, will follow the same policy, with the added advantage that, where it is desirable, we shall be in a position to give the subjects a more extended treatment than was possible in a weekly publication.

Frequently we have been asked how we gather and prepare the current scientific "news." It is done by the Editorial Staff in the home office, which keeps its finger on the pulse; it is done also and largely by correspondents in the leading cities, the Universities, and the laboratories of the world. Another fruitful source of information is the voluntary contributions of scientists, engineers, inventors and others, who find that our pages are open to anyone who has a plausible theory or a proved accomplishment to place before the public.

Neither "high brow" nor "popular," we aim to strike a reasonable mean between the two. The Editor both "writes down" and "writes up." One day he may translate the Einstein theories into the nontechnical phrases of everyday life; the next day he may have to take the crude drawings and description of an unlettered mechanical genius, and bring it up to the standard of the draftsman's drawing, and of accepted, intelligible English. Writing down from technical to every-day English is the more difficult half of our work. Some years ago we requested a leading American bridge engineer to write for us an article, describing how he went about the task of designing a large cantilever bridge. He demurred on the ground of the time and labor that would be involved; "I could dictate in an hour an article for a purely engineering publication—it would take me many hours to do so acceptably for the SCIENTIFIC AMERICAN."

Are we a "popular" magazine? Yes and No. The SCIENTIFIC AMERICAN is popular in the sense we have explained above; we write for the *populus*, the whole people—for the factory president and the college professor no more than for the workman and the student —for the farmer with his agricultural college training no more than for his hired man. In these feverish days the term "popular," as applied to scientific journalism, has become first cousin to the term "sensational." Mere sensationalism the SCIENTIFIC AMERICAN abhors only less than the Devil hates holy water.

In concluding this reference to our aims and purposes, we wish to make it clear that, although we appear henceforth in a more bulky form and in a new dress, there will be no change in the essential features of our policy as we have outlined them above. Merely, we shall do the work better. In a monthly, this task of recording and explaining the world's progress in science (knowledge), art (accomplishment), engineering, industry and other related fields, can be done more thoroughly, with better illustrations, and a more complete recording of the facts, than was possible in the rush of a week-to-week publication.

Ships of the Air and Ships of the Sea

THERE is a much closer parallelism between the dirigible, the ship of the air and the Atlantic liner, the ship of the sea, than most of us realize. The greater part of the disasters to the early dirigibles of the indefatigable Count Zeppelin and not a few of those that befall the airships of today, are due to a failure to realize how largely the laws which govern the steamship govern the airship also. Some simple considerations of the problem will convince one of the truth of this statement.

In the first place, from the time of her launching, when the ship has slipped safely from her ways and the whole vast but comparatively fragile shell of the ship is water-borne, ceaseless care has to be taken to prevent her hull from coming in contact with that very Mother Earth upon which it was laboriously constructed. Let the captain of a well-found ship of today have plenty of offing, good charts, a reasonable number of opportunities to take observations, and he knows that his ship is safe. Except for the risk of collision with other ships which, thanks to modern inventions, is a remote contingency, the only time when the vessel is in danger of loss is when she approaches land where, through carelessness or unforeseen chances of wind and weather, she may run upon a shoal or be piled bodily upon the sands or rocky coast of the shoreline. When the hull of the ship has to be subjected to its periodical inspection, she is towed with great care and at very low speed to a costly dry dock, in which she is brought to rest gradually upon a specially prepared bed of blocking, so distributed that no part of the hull will be subjected to undesirable stresses. In other words, the ship is designed to float in a fluid medium which is her proper home, and ceaseless care is exercised to maintain her in that fluid and prevent, above all things, any contact with solid land.

Now, the ship of the air, like the ship of the sea, is designed, also, to float in a fluid, known as the air; and, provided that her hull is built with proper strength, she is perfectly safe so long as she floats in that medium. The great mistake of the builders of the early Zeppelins lay in the fact that, whenever the airship came into port, so to speak, she was brought down to land, "beached," as it were, and, because of the winds, whirlings and cross currents of the air, she was exposed to very great danger of wreckage whenever such landings were made. In other words, the early airships were subjected to the difficult and always rather risky operation of dry docking at the end of every trip. A tabulation of the wreckings of the early Zeppelins will show that the majority of the disasters which occurred were due to the attempts to bring them safely to earth.

Many years ago, the SCIENTIFIC AMERICAN drew attention to these cardinal facts and suggested that we should handle the dirigible as we handle the ship which, when it comes into harbor, steams up to a mooring, makes fast to it head-on, leaving its hull free to swing with the tide; thereby subjecting the vessel to no greater strain than that which comes from the pull of its mooring cables, which, being taken at the head of the ship, is distributed harmlessly throughout its structure. During those early years of experimentation the SCIENTIFIC AMERICAN suggested that the airship, like the steamship, should not leave its native element when it comes into port, and that it should swing to a mooring like its sister of the sea. Subsequently, this principle was worked out successfully in Great Britain, and it has now been accepted as the only satisfactory way to meet the problem. Dirigibles of the largest size have been moored to tall steel masts and have ridden to these moorings, in one case for many weeks on end and in stormy weather, most satisfactorily. The advantage of this method is that when the airship has to go into dry dock, that is, into its air shed, a suitable day with calm weather can be chosen and the transfer made without undue risk.

However, the practice of bringing the airship to earth is still too general and it involves an enormous amount of risk. Indeed, there is something positively absurd in the sight of 300 to 400 human beings hanging on to a vast number of ropes and trying to guide a monster dirigible into dry dock. Those of us who went down to Mineola to see "R-34" two years ago must have realized what a crude method of handling this was, in an age which prides itself upon the high level of development to which practical engineering has been carried.

What Is the Matter With Our Schools?

OPINIONS will vary widely as to the propriety of expecting educated men to have at their immediate command a mass of isolated facts of the sort called for by the Edison questionaire. Under many circumstances the man who knows where to find these facts is quite as well off as the man who carries a full cargo of them in his head. And since the college training of the present day leans toward the mastery of sources, the ability to read profitably, and the proper handling of facts rather than their mere warehousing, it may not be fair to condemn the colleges on the mere ground that their graduates have not at immediate command a large proportion of the facts which underlie their education.

Critical examination of the results of Mr. Edison's questionaire will deny this hope. Mr. Edison says that in his business he can't pardon the man who has lost contact with his facts. Anybody else who wants to pardon him may do so—provided the forgetting is on a respectable basis. The man who does not know the leading city of Newfoundland, the identity of Balzac, the distance from Minneapolis to St. Paul, can look these things up; having done so, he is as well off as the man who does know. But anyone who calmly tells us that Nova Scotia is Newfoundland's metropolis, that Balzac was a Brazilian patriot, that the twin cities are 250 miles apart, is just plain ignorant. He doesn't know that he doesn't know; presumably he will act on his false premises as though they were valid. And his "information" is so utterly and absurdly at variance with the facts; a man who doesn't know that these things can't possibly be is lacking in common sense.

Our educational institutions are not responsible for the existence of such men. But large numbers of these men are being turned loose upon the world holding degrees from colleges and universities of high standing. What is wrong with the system under which this can occur?

One thing that is wrong Mr. Edison makes very clear. The average college student may have one or two subjects in which he is especially interested and in which he makes a grade of B or even A. But the average collegian, as regards his general level, is just a C man. This means that he is right from 60 to 75 per cent of the time. What business, profession, trade, or other means of doing his part in the serious business of the world is open to him, in which he can possibly get by with any such showing?

Even the grade of C is often teased out of him. His instructor stands over him while he recites, correcting each mistake as he makes it, and finally succeeds in dragging out of him what by due exercise of charity may be recognized as an approximately 60 per cent performance. If, on his examination, he falls below the ultimate level of passable mediocrity, his class room work done in this manner, and his outside assignments probably done through more active assistance, are appealed to to bolster his average. The whole aim of the system is to boost the student by any means over that 60 per cent hurdle.

Our Point of View

We have taught all branches of college mathematics, always to men who had come to us direct from the prerequisite courses. Eighty per cent of them could not pass the easiest kind of an examination in the more elementary course, to save their lives or their degrees. And are they apologetic or embarrassed? Not they: they are indignant that they should be expected to know anything about last year's work. They protest at being marked down because of such ignorance: this isn't an algebra course, it is calculus, seems to be the theory; what difference does it make whether I know any algebra or not?

The system of examination is largely responsible for this spirit. Mr. Edison points out that a man with note-book and text at his disposal, who cannot prepare himself to squeeze through a written examination of which the date is fixed weeks in advance, must be mighty poor stuff. And then, having passed such an examination, as conducted in our schools and colleges today, the student will let go of the subject with the feeling "There; that's over with! I shan't ever have to worry about *that* again."

The only satisfactory examination is an oral one. Here the evasive or the ambiguous answer can be followed up, and the full depths of the candidate's ignorance or knowledge plumbed. On every ground oral examination is the way to find out what a man knows, written examination the way to avoid finding out. Is this the reason why the written test is so general throughout our educational system?

Whatever the cause, whatever the remedy, Mr. Edison's questionaire furnishes new concrete evidence of what many of us have long suspected. Our educational system is in a bad way. The only people whom it educated successfully are those who have the capacity for educating themselves against all obstacles. Its real mission, of educating the average student to a point above what he could hope to attain unaided, is not being fulfilled. If the universal tendency to make school more attractive, the work more easy, the learning more appealing to the student, is responsible for this, let us acknowledge it and get back to the severer ways of a past generation. Learning carried no sugar-coating in the little red schoolhouse on the New England hill, nor in the college of fifty years ago. If the present generation is eating off the sugar and rejecting the pill, we should change the mode of administering the dose.

A Navy Equal to Any

It would not be possible to find a stronger argument against the immediate construction of the six 42,300-ton battleships of the "Indiana" class, than that which is presented by the comparison of naval strength in our article on page 11 of the present issue. This analysis deals, it is true, with capital ships (battleship and battle-cruisers) only; but when we remember that the General Board has affirmed, with the strongest emphasis, that the battleship is "the backbone of the navy," it will be felt that we have chosen the true basis upon which a comparison of material and military strength should be made.

Although the introduction of the question of age, as we have used it, is something new in such comparisons, it is surprising and unfortunate that this most vital factor has not been applied before. Comparison by mere displacement has little significance or value. A naval expert would rather be told *how old* a ship is than *how big*. Single salvoes served to destroy three battle-cruisers of Beatty's fleet that were built in 1908 and 1912—it is probable that the "Hood" of 1920 would have taken those salvoes without impairment either of her speed or fighting power.

We wish to make it perfectly clear that the steady fall in the value of a capital ship is not due to material depreciation (it is too well taken care of for that) but to the great improvement upon its design, which marks the ships that are built in each successive year. Thus, the appearance of the "Dreadnaught" instantly relegated all existing battleships to the second line. The "New York" in 1924, considered by itself, with no reference to any other ship, will be 100 per cent efficient; but measured against the "Indiana," she will be but one-third efficient.

The General Board of the Navy has declared itself for a navy equal in strength to any other and Great Britain, who, of course, is most nearly affected, has announced her cordial acceptance of that policy. But if we push on to completion, in time of peace, the huge addition to our fleet which was contemplated in the 1916 program—a war program—we shall not only, so far as "the backbone of the navy" is concerned, be equal to the next strongest, but we shall be twice as strong as Great Britain and equal in strength to Great Britain and Japan combined. How so? Because the bulk of our capital fleet, being absolutely new and up to date, will have suffered no military depreciation.

Has the American nation any such ambition as that? It has not; nor is the taxpayer prepared, just now, to lighten his already depleted purse to the extent of the several hundred millions of dollars which he would have to hand over to gain such naval predominance.

The fleet is battleship topheavy; the General Board has been so obsessed with big-displacement, big-gunned ship that it has failed to make adequate provision for what is known in naval parlance as "information." Information can be gained only by battle-cruisers, fast scouts, and scout airplanes operating, far afield, from those mobile, floating bases which are known as aircraft carriers. In vessels of this type we are as deplorably weak as we are, or shall be, immoderately strong in battleships. It should be the future policy of the General Board to rectify the balance.

The Value of Disasters

Panic of judgment, induced by engineering disasters, has no right or place in the scientific mind. In the popular mind it is inevitable; as the files of the daily press will show. The workaday world is controlled by its day-by-day impressions. The initial success of a new invention means a "revolution" in the art; a subsequent disaster, involving loss of human life, means, for the average man, the curtain on the last act.

Not so with the scientific mind, which, delving patiently in the ruins, brings up many a golden nugget of evidence; traces the disaster to its ultimate cause; and writes down a series of findings, upon which the art may go forward to a more secure construction.

The fall of the first St. Lawrence River bridge during its erection, when a huge cantilever, some 1500 feet in length, with its 400 foot tower, crumpled up and fell into the river, was appalling, even to the engineering world, whose members might well have asked if there were some unsuspected law, which forbade the use of the cantilever principle in a span of this length and form. But there was no panic—rather a resolve to find the initial cause of the disaster by a patient examination of the records and of the fallen structure itself. The disaster was traced to a very insignificant cause—the failure of some small angle-bars, 3½ inches in width, which were supposed to hold in place the parts of the huge compression members which failed. The engineers of the bridge apparently never suspected that these bars would be unequal to their work. They represented standard ideas of commercial bridge building in that day. It took the failure of this monumental structure with a loss of eighty lives to point out the unsuspected danger which lurked in the latticing of huge compression members, as practised by the bridge companies. Safer rules of construction were adopted, and the security of big bridge construction safeguarded.

It took the Baltimore conflagration to teach us the strong and weak points of our much vaunted systems of fireproof construction. Only when San Francisco, after repeated warnings, had seen the whole of its business section shaken down and ravished by fire, did she set about the construction of a city which would be proof against fire and earthquake. It was the spectacle of maimed and dying passengers being slowly burned to death in the wreckage of colliding cars that led to the abolition of the heating stove and the oil lamp; and it was the risk of fire, coupled with the shocking injuries resulting from the splintering of wooden cars in collisions, that brought in the era of the electrically lighted, strong and incombustible steel car. So, let us hope, the investigation of the loss of "ZR-2" will lay bare the particular fault of design or material, which caused the disaster, thereby recovering for airship navigation as a whole such loss of prestige as it has suffered.

The Control of Atomic Energy

The first announcement of the enormous potential energy stored up in a particle of radium produced a state of the public mind which varied from mild incredulity to vehement denial. But the proof was forthcoming, and scientific authority has convinced the world that there are substances which send forth ceaseless streams of energy, and (here is the wonder) do so with a loss of substance so small that it takes the most delicate processes of the physicist's laboratory to measure the change.

It had long been suspected that there was a vast storehouse of energy locked up in the atom, and the production of radium and the measurement of its kinetic activity set the seal of positive scientific proof upon the theory. But, more than that, it has revealed to mankind the amazing, the tremendous fact that we are in the presence of a storehouse of energy so vast and so intensive that he who shall first unlock the door will be possessed of a power in the presence of which all the vast potentialities of the world's store of coal, oil, waterpower will literally sink into significance.

Hence it was very natural that the subject of atomic energy should be well to the front in the recent Convention of Chemists in this city, where some of the best papers were devoted to a study of the ever-recurring question, these days, as to how and whence the coming generations will secure the needed energy for light, heat, transportation and the thousand-and-one activities of human life. In this search we have at one time or another considered (with more or less doubt as to their filling the huge demand) coal and oil, natural gas, the energy of the earth's rotation and that of the wind, the tides, and the waves. Waterpower, of course, is included; and we are told that the solar heat that beats upon the Sahara desert represents, in energy, the equivalent, daily, of some six billion tons of coal. But none of these possibilities is so attractive as that of atomic energy.

It must sometimes seem to the man who considers the question of the power of the future that nature has conspired against us. Every source of power that we have learned to utilize involves the using up of some material resource at a rate absurdly more rapid than is consistent with its continued availability to many generations of our descendants. Every source which seems a permanent or reasonably persistent one defies our efforts to put the harness to it. But the chemist reassures us with the statement that he is making progress in his attack upon the most spectacular and the most inexhaustible of all the suggested sources of energy. And when we survey the happenings of the past twenty years, and see to what base uses the best products of science and invention have been put, we may be reconciled to the slowness with which we approach the ultimate goal of unlimited free power.

It was Rutherford who said "the race may date its development from the day of the discovery of a method of utilizing atomic energy." So enormous is this energy that it will confer upon the man, or the race, which learns to release and control it, a power only less than that of the Omnipotent. Before that day arrives let us hope that a way will have been found to put more of the human in what we are pleased to call human nature.

The monumental Roman aqueducts are an historical landmark. This one stands today at Tarragona, Spain

The Chinese are the earliest recorded bridge builders. This structure, built entirely of marble, has both architectural beauty and dignity

Some Aspects of Bridge Architecture

A Bridge Should Combine Grace and Dignity With Strength and Permanence

By Dr. Eng. Gustav Lindenthal, C.E.

"ARCHITECTURE," as defined by Ruskin, "is the art which so disposes and adorns the edifices, raised by man for whatever uses, that the sight of them may contribute to mental health, power and pleasure." Among the prominent edifices of mankind are the great bridges. Their architecture in all countries marks in a peculiar way the progress of mankind in the art of construction, considered as an index of its civilization and culture.

It is a characteristic fact that the architecture of buildings precedes everywhere the architecture of bridges; the reason being that structures growing to height and resisting merely weight and loads are easier to plan and to build than are structures carrying weight and loads over free space. It requires of the builder greater skill and judgment to create a self-supporting stone arch or a high-arcaded aqueduct than to erect a pyramid or obelisk, a palace or spire.

Thus, the Egyptian masterbuilders were able to erect 4,000 years ago marvellous temples, of so enormous a size and of an architectural beauty so magnificent, that no structure built since then anywhere can equal them. Yet the flat stone roofs of their gigantic halls had to be carried on columns, standing close together; for the art of bridging space with arches was unknown to them. It was also unknown to the wonderfully skillful Hellenic architects. Had the ancient Egyptians or Greeks known the art of arch construction, they would have bridged the Nile as the Romans bridged the Tiber.

The Era of Bridge Architecture commences with the stone arch. The invention of the arch is usually credited to the Etruscans. Although stone arches appeared about 600 B. C., it was many years before Roman architects were bold enough to attempt stone bridges over the Tiber, the first of which were built in the first century B. C. Some of these are still in use.

The earliest forms were, of course, crude; mostly the half circle on low abutments. With increasing experience, higher and bolder arch bridges were built on piers, many in the form of long viaducts and aqueducts consisting of two and three stories of superimposed arch arcades. They were great achievements when we consider that the Roman architects had only poor equipment for laying out their work, and that the tools of their artisans and craftsmen were of the simplest kind.

What wonderful vaulted monuments these great masters, whose very names are unknown, would have created in that wealthy age, with its love of the beautiful and its exquisite sense of proportions, had these men possessed the modern accurate knowledge of the strength of materials and of mathematical statics! But such knowledge did not exist until less than 200 years ago. A few empirical rules, evolved from experience and failures, sufficed for the construction of the architectural wonders in the form of castles, great cathedrals, palaces and bridges through all the centuries, extending from ancient times to the beginning of the Renaissance. As it is, throughout Europe we find evidence of refined architectural forms in the stone arch bridges. There must have also been many fine wooden bridges; but no trace has been left of such perishable structures.

Towards the end of the sixteenth century, the opulent, art-loving Italian cities, also encouraged competition of designs for beautiful bridges. The same architects that designed their churches and palaces, designed and built bridges. From that period we have inherited the famous Rialto Bridge in Venice by Antonio da Ponte, and the beautiful elliptical stone arch bridge Ponte della Trinita in Florence by Bartolemeo Amanati. There are also a number of smaller bridges, veritable architectural gems, by the contemporary Andrea Palladino, the leader of the Italian Renaissance in architecture. The flat segmental form of arch makes its appearance; the piers receive a slimmer and more elegant form; the adjoining river shores are terraced and brought into architectural harmony with the bridge structure as a whole. Decorative sculptures commemorate historical events and give expression to the dignity of the community. The cunning workmanship of the bridge balustrades, the graceful profiles of the cornices, the imposing gates and tower entrances, all speak to us of the ambition of the masterbuilders, of the civic pride and public spirit of the people, and of their love for the beautiful and harmonious in their surroundings.

One hundred years later the leadership in artistic bridge designing went to France, where a great impulse had been given to Arts and Sciences by Louis XIV. M. Perronet was the recognized master bridge builder of that time. His designs are distinguished by elegance and stateliness of proportion and finely executed stonework. He developed the flat elliptic arch, and to him we owe many beautiful stone bridges in France. The first stone bridge in St. Petersburg over the Nern was also from his designs. His method appeared also in the London Bridge. Perronet's bridges at Neuilly over the Seine and the Concord bridge in Paris will always be regarded as among the finest examples of architectural distinction in stone arch construction.

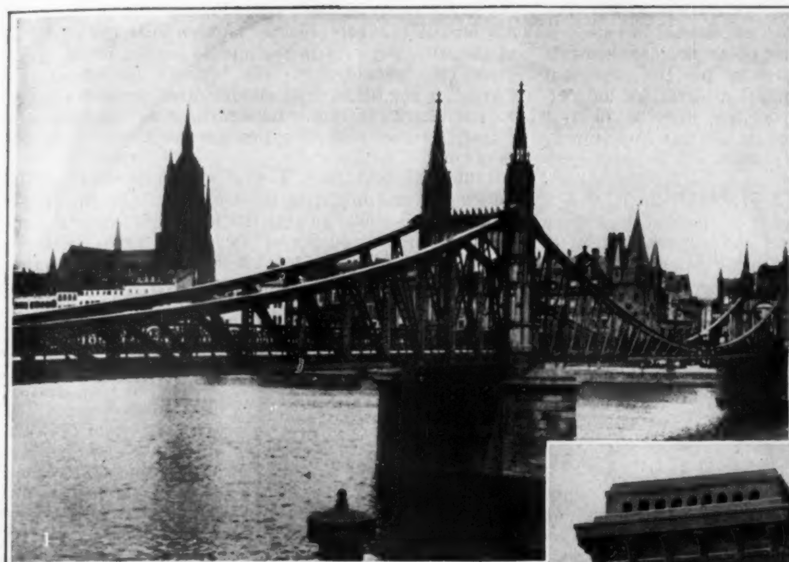
When iron came into use as a material for bridges about 150 years ago, it was a new material for architects. It gave birth to a new architecture, since it could be used to resist tension as well as pressure. It has obtained its most æsthetic value in the large suspension bridges built in the last one hundred years. Some elegant arch designs carrying streets and boulevards across the Seine in Paris were executed in cast iron. With iron and steel, larger spans than with stone became possible, and the way was open to a grander bridge architecture than was ever possible in stone.

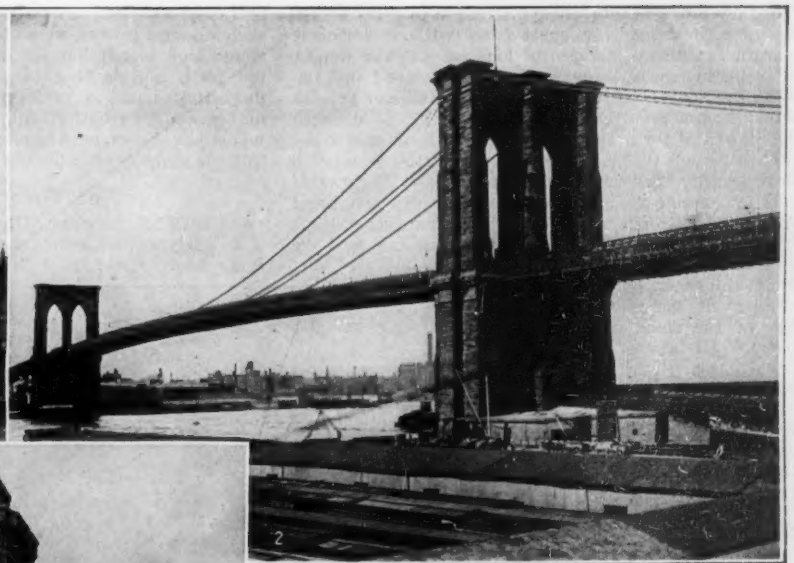
With the railroads came a sweeping change in transportation, in bridge construction, and also in bridge architecture. Today the desire for aesthetic structures is struggling with utilitarianism. Few only of the large iron railroad structures have a pleasing appearance. The great majority range from poverty-stricken simplicity to downright ugliness. The new material finds its best expression in the graceful curves of the suspension bridge, in the forms of the massive or latticed beam, and in the lofty and long-span arch.

The very rapid development of the technical sciences, including statics, led, it is true, to great precision and economy in the dimensioning of bridge structures; but, unfortunately, the fact was overlooked or ignored that iron and steel are subject to corrosion and are more perishable than stone. While stone bridges will endure for ages with little care, iron bridges require painting and continuous care to preserve them against the destructive elements in the air. And so it may come to pass that in the coming ages, say in the next 2,000 years, stone bridges, including the great Roman viaducts built in southern climates, where frost is not known, may still stand, with 4,000 years of life to their credit, as monuments of a past great civilization, while nothing may remain of the great iron and steel structures of the present day, but the stone piers and abutments, on which they were reared. Unless care is taken to build iron bridges in more durable form, and exercise continuous vigilance in their maintenance, they will surely be past their usefulness at some future time when our tall buildings of the skyscraper type, in which the steel frames are protected against corrosion, will still be giving good service to mankind.

The necessity of preserving large and costly iron and steel bridges against early decay should lead to a special type of protective architecture in bridges, as the same necessity has already done in the construction of steel-framed buildings. In fact, the beginning has already been made with smaller steel structures, by covering them with a coating of cement mortar.

The chain suspension bridge at Clifton, England, owes much of its beauty to the massive and appropriate masonry towers



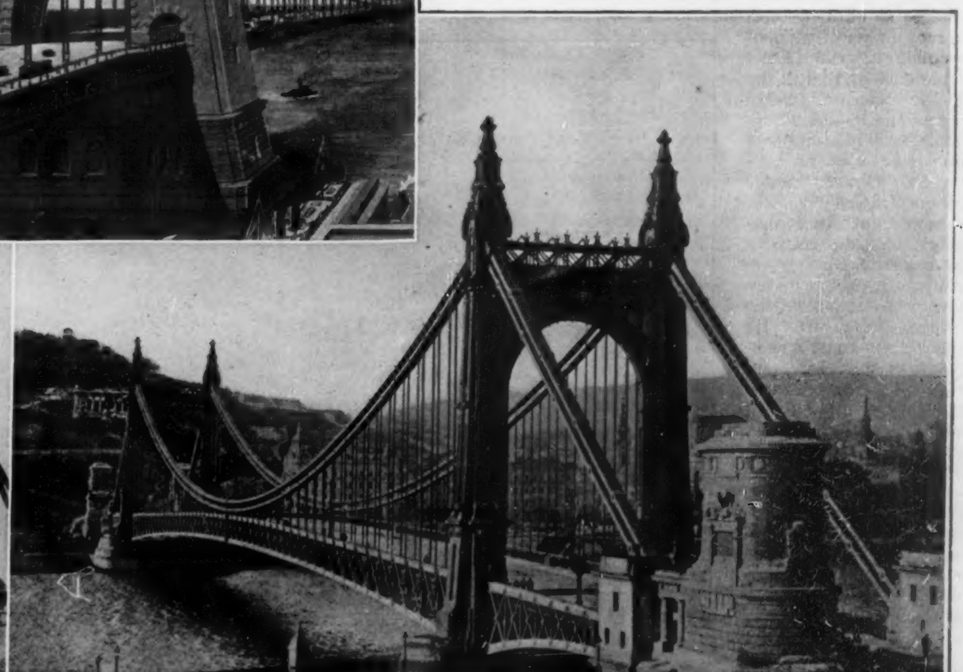


But this is a mere substitute for paint and does not promise a sure degree of durability, since the coating is liable to crack off. Pleasing architectural effects are not possible with such mongrel combinations, nor with the new material, "armored concrete," where it follows the lines of a framed steel or wood structure.

Concrete reinforced by steel offers great architectural possibilities for bridges. It is, indeed, the best material for masonry bridges of long span; but its most useful function in bridge construction should always be in the form in which the Romans, the inventors of concrete, used it, namely, in the form of an arch. With modern theory and resources, masonry arch bridges can be built of much longer spans than the Roman and Italian masterbuilders dared to use. Their longest span, built at the end of the fourteenth century over the Adda in Italy, attained a length of 251 feet. Concrete lends itself readily to moulded forms of decoration, although this can never attain that distinction which the stonecutter's art can produce in stone.

The architectural character of massiveness and power is obtainable to an unprecedented degree in iron and steel bridges of large size, and can further be enhanced by combination with great masonry abutments and towerlike piers. Such examples we have in the Menai Suspension Bridge (in Wales) with its massive stone towers supporting the heavy iron link chains from which the roadway is suspended, in the beautiful Budapest Suspension Bridge and in the Brooklyn wire cable bridge. Fine examples of combinations of iron arches and impressive stone architecture are found among the bridges over the Rhine and Elbe in Germany, in the Hell Gate bridge over the East River and in the famous steel arch at St. Louis and the Washington arch bridge over the Harlem River.

The majority of iron and steel bridges have, everywhere, been built for railroads. The much greater loads on railroads required heavier bridges than for mere highway traffic. Iron bridges, being susceptible of closer computation than stone bridges, were there-



1. The Gothic treatment of the towers of this beautiful cantilever bridge at Buda Pest harmonizes pleasingly with the Gothic churches of the city. 2. The Brooklyn Bridge is greatly admired for the simple and constructively appropriate design of its stone towers. 3. The mantle of stone which covers the towers (840 feet high) of the Hudson River Bridge, not only will protect the steel work, but will secure a satisfactory effect of mass and stability. 4. The masonry towers of the Tower Bridge, London, are designed to match the surrounding city architecture. 5. Note the fine architectural treatment of the anchorages and towers of this suspension bridge at Buda Pest

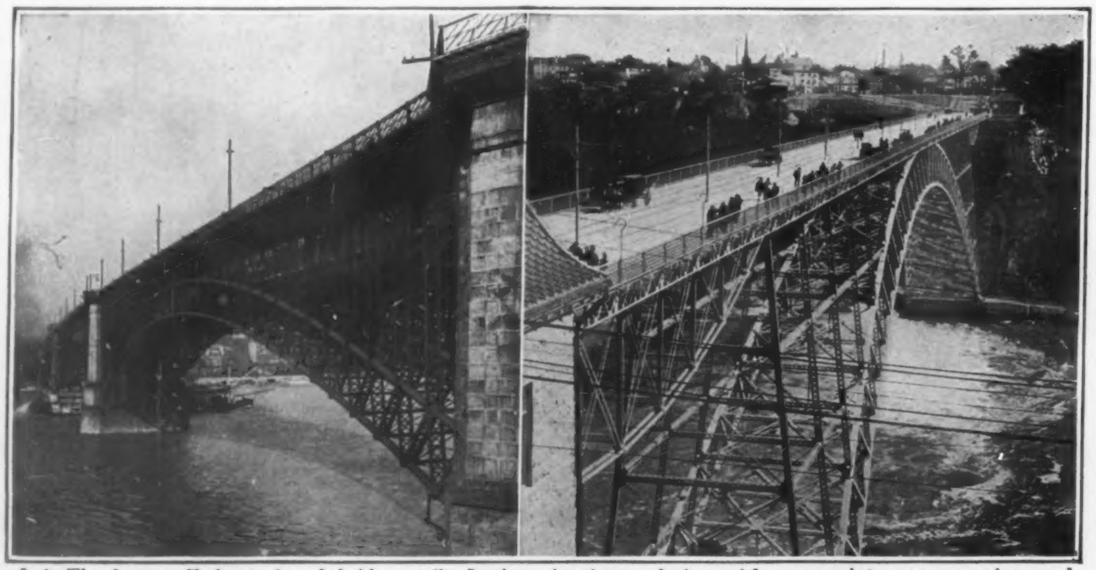
fore built with an exaggerated regard for economy, so that they provided only enough strength to carry safely the prescribed loads, in most cases without sufficient margin for future increase of loading. As the weight of trains increased, large, costly bridges were found too weak and had to be replaced with structures of greater strength; but even then, no greater margin of strength was provided for a further increase of loads under the necessities of traffic. These cheese-paring economies have become very costly on all railroads. Because of this lamentable want of foresight, already, on several American railroads there have been four generations of metal bridges. Meanwhile, stone arch bridges have required no such rebuilding. The many thousand metal highway bridges throughout the country are of the same character. In almost all such cases there was and is no thought of architecture, or of durability, or of pride in the art. In the fierce commercial competition, the most naked utilitarian considerations are allowed to govern the design for such structures.

The art of steel bridge building, in the great majority of cases, has thus become a commercialized trade which has been prostituted, under the pretense of scientific economy, to the production of the cheapest structures that will carry the loads. Even so, we witnessed a few years ago the collapse, merely under its own load, of one of the greatest cantilever bridges ever attempted.

The Forth Bridge, Scotland, with its massive tubular compression members, 12 feet in diameter, and its two 1710-foot main spans, gives an impression of strength and permanence

As a matter of fact, supposing that two bridges for, let us say, a river crossing are designed with equal strength, one of them with the strictest regard for economy and the other designed not only with regard to economy but also with an eye to its fine architectural appearance, it will be found that the cost of giving beauty and dignity to the bridge is insignificant compared with the total cost of the whole structure.

Of late years, engineers have increasingly realized the necessity of providing for the durability of their bridges by encasing their steelwork, as far as possible, in masonry or other nonerodible material. A notable case of this is the Tower Bascule Bridge across the Thames, London. Here, not only was an outer wall of protective masonry built around the main steel towers, but this masonry was designed to harmonize with the architecture of the immediate surroundings of the bridge. The result, from the architectural standpoint, is highly successful, and the Gothic towers harmonize pleasingly with the suspension trusses, the roadways and the bascule portions of the main floor. If care is taken in painting as much of the steelwork of this bridge as is exposed, there is no reason why its life should not run into the thousands of years.



Left: **The famous Eads steel arch bridge at St. Louis, a handsome design with appropriate masonry piers and abutments. *Right:* Beautiful arch roadway bridge of 840-foot span across the Niagara River**

The latest notable recognition of the call for permanence in costly bridge structures, and for architectural effects which will express the main constructional feature of a bridge, is the North River Bridge across the Hudson River, New York, which, because of its vast size and monumental character, to say nothing of its urgent utility in the transportation problem of the metropolis—calls loudly both for architectural dignity and the assurance of permanent life.

The principal elements in this structure are the cables and the towers. The preservation of these will be met by encasing the cables in continuous bronze or copper tubes impervious to the weather, and in the case of the towers by clothing them with walls of masonry throughout their entire height. The huge anchorages, 400 feet square by over 200 feet high, are built of masonry by necessity, in order to secure the needed mass. The skeleton steel towers, were they not clothed in masonry, would look to any but the eye of an engineer entirely too frail, and lacking in dignity for the important duty they have to perform. Considerations of permanence and architectural nobility are the motives which have prompted the clothing of these huge towers in their mantles of enduring granite.

A New Theory of Flight

A GERMAN inventor, Gustav Lilienthal, has been studying for some years the wing structure of large birds, the frigate bird being taken as a type. He remarks: "Since the bird without any expenditure of energy not only lifts its own weight but is also still driven forward, it seems certain that if we can discover the source of the energy by which this is accomplished, we shall have gained information very useful with respect to the driving of air craft. By means of the propeller the motor creates an exclusively forward drive to overcome the backward pressure acting upon the airplane. These pressures are produced by the combination of the head resistance of the body of the craft and the rearward slanting pressure of the lifting impulse beneath the wings. If we could find a way to eliminate these resistances, we should at once be able to lower the required power of the motor."

Countless experiments and observations extending over a period of many years, into whose details we cannot well go, led Lilienthal to construct an artificial plane having a cross section similar to the middle part of that of the wing of a frigate bird. The plane was first placed in a room carefully protected from external air currents and set in rapid motion, the direction of the currents thus produced being shown by small pennants placed on the upper and the lower sides of the frame. On the upper side of the plane the current of air followed the curvature of the profile exactly, whereas on the under side of the plane a vortex was produced, in such a manner that the air flowed along the under side of the plane *from back to front* whereupon the spirals of the vortex wound themselves outward like the horns of a ram and flowed off right and left into the surrounding air of the carefully closed room.

From a study of the longitudinal profile of the frigate bird it can very readily be seen that the portions of the wing adjacent to the middle portion of the wing from the "shoulder" to the "elbow" and from the "wrist" to the tip have an oblique direction with respect to the lateral current. Because of this fact the kite principle comes into operation and an upward impulse is created.

Lilienthal next built a new model representing an entire bird and imitating the longitudinal profile of the frigate bird wing. In this the motion of the pennants showed that the vortex of air slowed off toward the body and toward the tips. Especially toward the tips the current of air was so strong that even at the ends the pennants flew out in the longitudinal direction of the wings. In other words, directly-cross-wise. The direction of the pressure of the air resistance upon the root and the tip of the wing is therefore no longer slantwise toward the rear, but rotated at a right angle in the longitudinal direction of the wind. Hence there is no longer resistant direction of force, but only the buoyant impulse. In the middle of the wing where the current of air presses strongly against the downward bent forward edge of the wing, the direction of the pressure is inclined forward. At this point the driving impulse is entirely forward. On the upper surface of the wing a suction begins to be exerted, but the direction of this lifting force cannot be exactly determined. He next exposed his models to fresh sea breezes.

As he had expected, his planes and models were subjected to a remarkably strong upward drive—so that not only the head resistance of the forward edge was overcome, but the freely movable experimental planes were moved in front of the plumb line. The excess of the forward impulse over the head resistance needs be but slight, since it produces a constant acceleration. The largest model had a wing surface of 30 sq. m. It was observed in these large models that there was a backward bow of air under the tail also. In the case of real birds this current of air strikes the soft plumage of the body and thus overcomes the head resistance of the latter.

The experimenter concludes that when the wind lacks the "friction buoyancy" birds are as unable to soar as they are in a dead calm; even if the bird had acquired a great forward velocity by means of beating its wings and volplaning, it would still be unable to soar. In both cases it would lack the source of energy given by the buoyant impulse without which source no work could be done.

Lilienthal does not hesitate to declare that the large model he has built, for which we are indebted to *Kosmos* (Stuttgart) for April, 1921, is destined to be the form of the future airplane.

Bitumen in Palestine

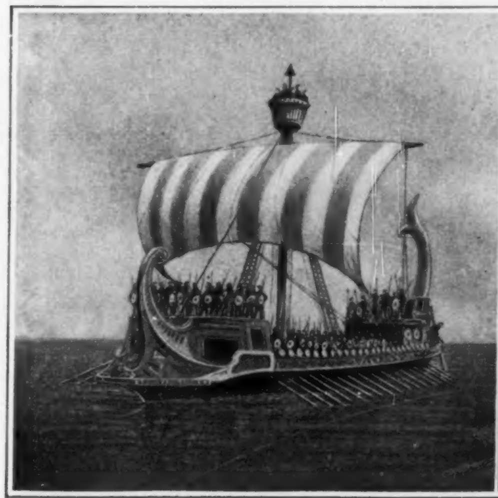
BITUMEN is gathered in Palestine from the Dead Sea, where it is found floating on the surface of the sea. Prior to the war this bitumen was gathered and turned over to an American, who lived in Jerusalem, who in turn exported it by special permit. It is said that the annual export amounted to approximately 50 tons, and that practically the entire output was sent to Germany, where it was used in preparing the gloss for patent leather. At present very little of this bitumen is being gathered.

From Trireme to Dreadnought

The Development of the Warship from Ancient to Modern Times

By J. Bernard Walker

IT is not possible to name any definite date or even period when the warship, even in its most crude form, came into existence. It is probable that from the earliest days the mariner found it advisable to carry with him arms for defense, for we know that even centuries before the Christian era, those wonderful sea traders, the Phoenicians, were armed sufficiently to protect themselves against the pirates that infested the trading routes of those days. The development of the warship is necessarily associated with the development of the merchant ship. In fact, the one grew out of the other. The difference between the two was that, whereas the merchant ship relied principally upon its sail power, the warship depended principally for speed and maneuvering ability upon its oarsmen.



Greek warship of the date of the Salamis battle

Typical Roman Trireme of the Punic Wars

Our earliest record of sailing ships is to be found upon those wonderful historical sculptures, engravings and paintings with which the ruins of ancient Egypt abound.

Egyptian seamanship, however, was confined almost entirely to the navigation of the Nile, and it was not often that their vessels ventured beyond the Nile delta into the waters of the Mediterranean. To them, however, must be credited the familiar form of the ancient ship, with its curving prow and lofty stern, and with its long bank of rowers. This form persevered for some 3000 to 4000 years, and may be seen (of course greatly modified) in the ships of the Greeks, Romans and the Venetians.

The first great race of seamen was undoubtedly the Phoenicians, whose enterprise carried them throughout the full length of the Mediterranean and ultimately through the Straits of Gibraltar and to the coasts of Britain.

We know from the Syrian sculptures that the Phoenicians, as early as 700 B.C., were building biremes, with two banks of oars; and that their vessels must have been seaworthy and themselves great navigators for those early days, is shown by Herodotus, who records that Neco, king of Egypt, failing to build a canal from the Mediterranean to the Red Sea, sent a crew of Phoenicians on a voyage around Africa, which, wonderful to relate, they succeeded in accomplishing, leaving from the Red Sea and coming back through the Mediterranean.

It is probable that the Greeks modelled their earlier ships after those of the Phoenicians, and we present an illustration of the type of Greek warship which took part in the battle of Salamis. The meager records of history fail to tell us just when it was that the ship followed in its structure that of the skeleton of the fish, with backbone and ribs, but we know that the Greek ship was provided with keel and ribs to which latter the ship's planking was fastened by means of tree-nails or pegs of wood. There was also a certain amount of use made of bronze nails. A single mast with one square sail was used, and this was characteristic of the early warships for many centuries. Homer tells us that the Greek warship was manned by from twenty to fifty rowers, who sat upon transverse seats or thwarts. There was a cabin forward and another aft. On the forward cabin deck was the lookout, and at the stern of the after cabin was the helmsman, the Greek ship having two steering oars, one on each side of the stern post, which were connected by a cross bar to which was attached the tiller. The stern of the ship was carried up in a huge sweeping, ornamental tail. Up to the year 700 B.C., the largest ships contained fifty rowers, arranged in a single bank, but later an upper deck was added and a second bank of oars, such ships being known as biremes, and this was succeeded by ships with triple banks of oars known as triremes, of which no less than one hundred were used at the battle of Salamis. An invariable feature found on all warships was the ram, which consisted of a massive projecting spur below water level, and another ram-like arrangement to strike the ship between wind and water. Ramming was the principal tactic employed in ancient sea fighting, and it sometimes happened that the attacking boat suffered only less severely than the enemy.

As the Greeks followed the Phoenicians, so did the Romans, the Greeks, each developing and enlarging the ships of predecessors. The Romans are principally to be remembered for the development of their merchant marine, with its famous corn ships, which brought the produce of distant Mediterranean countries to Rome. In Roman history, as with the British Empire, the Roman merchant marine was the great bond between the imperial seat of power and the outlying provinces. Lucian has left a most fascinating description of his visit to one of these ships, and he speaks of the ship's cabins, of the sailors, mounting the lofty masts by the ropes and running out along the yards. Forward he notes the prow bearing the ship's name, and aft, the vessel sweeping up into a gilded goose-neck. He speaks of the capstan and the windlass, and finally, of the captain, "an honest fellow, bald-pated, with a fringe of curly hair." It should interest us here in America to know that the early Romans extemporized their fighting fleets, and that they set about their preparation only at the approach of war. Later, however, Rome was provided with decks; but it was not until the Punic War that this great military people appreciated the need for a navy. We know that the Romans defeated the Carthaginians with a fleet of one hundred quinquiremes and twenty triremes—that is, vessels with five and three banks of oars.

The first warships of all early nations were undecked, open boats. Then came the erection of forward and after enclosed structures, corresponding to the forecastle and poop, and following that, or contemporaneously with it, a central gallery or platform connected the two deck structures, for the use of the captain and other officials. Then, as ships increased in size, they became completely decked, and upon the deck of the

Venetian galley of the Middle Ages

One of the dreaded Viking craft

French warship, middle 14th century

Spanish two-decker of the Armada, 1588

The "Victory" of Nelson's day—a three-decker

fighting galley the troops were stationed, the rowers being below deck. The Roman galleys grew to formidable size. The single forward mast with a fighting top was retained, but for speed and power reliance was placed upon the oarsmen, the banks of oars being increased from the original single bank up to as many as five. There has been a hot discussion among the students of ancient warship construction as to whether the oarsmen were placed in successive tiers above one another, or whether they were not arranged on one deck with each two, three or more sets of oars operated through the same porthole, the oars being of different length to enable the rowers to clear each other. The argument in favor of the super-position of the banks of oarsmen is stronger, and certainly more agreeable to the pictorial records that have come down from ancient times.

Limitations of space forbid more than a passing reference to our illustration of a typical Venetian galley. The Venetians had a notable share in the development of both the merchant and the warship in early and mediæval times in the Mediterranean. We notice that the famous lateen sail which is still a favorite type in Mediterranean waters, was conspicuous on the Venetian galleys. The vessel shown is three-masted, and it marks a considerable advance in sail power over the earlier types of which mention has been made above. The advantage of using longer oars led to the adoption of an outrigger frame-work which was a continuous structure, running the full length of the ship in the wake of the oars. Ultimately, this was provided with outer bulwarks for the protection of the rowers and the fighting men. The galley has always held a conspicuous place in the annals of naval warfare, particularly of naval development, and the Venetian galleys were justly famous in their day. Even in modern times the genius of Italian naval construction has left a profound impress upon both the ships and the fighting material of our modern navies.

We have spoken of the Phoenicians as holding a high place both in navigation and seamanship among the ancient maritime peoples; but we think that even they must yield pride of place to the Scandinavians, than whom a more daring, robust and capable race of seamen has never existed. Unlike the cumbersome boats of their contemporaries, the ships of the Viking mariners were built with fair, easy lines, and with a splendid sheer, which carried bow and stern well above the reach of breaking seas. Not only did they navigate their own coasts, but the Vikings did not hesitate to reach out into the unexplored ocean to the westward, and it is now generally accepted that the Vikings landed in America several hundred years before Columbus himself. How they did their navigation, it is impossible to tell. The sun by day and the pole star by night and a certain fine instinct for the sea were about all that they had to depend upon. That such open craft as the Viking boats could outlive the Atlantic gales was proved during the time of the Chicago exposition, when a boat modelled after the remains of a Viking boat which had been discovered in a burial mound in Norway was sailed across the Atlantic for exposition at the Chicago fair. Leaving Bergen on May first, she reached Newport, Rhode Island, on June 13th. The captain stated that the "Viking" had proved herself to be an excellent sea boat, and that under her square sail to which a flying jib was added, she was able to make a speed that compared well with that of modern merchant vessels. The Vikings were a hardy race, and they never appeared to have made any effort to house in their boats, which were always long, lean, open and probably the fastest vessels afloat in their day. The rowers sat on thwarts, and, indeed, the vessel was in many respects similar to the open lifeboat of modern times. For shelter they used a pair of crutches with a ridge pole laid between, over which canvas was stretched, and the boat was steered by a rudder which was carried on the starboard side.

Our illustration showing a French warship of 1352 marks the closing of the period when ships were propelled by a combination of oars and sails, and when the fighting was done at close range by archers and crossbowmen, or by means of stones and weights thrown from crossbows and catapults, or hurled from the fighting tops. This curious vessel shows a bowsprit rising from a forward fighting platform, and aft we note the genesis of that lofty poop, which was destined to be a characteristic feature of warships of the Spanish Armada, which sailed toward fighting with artillery which was just about to open.

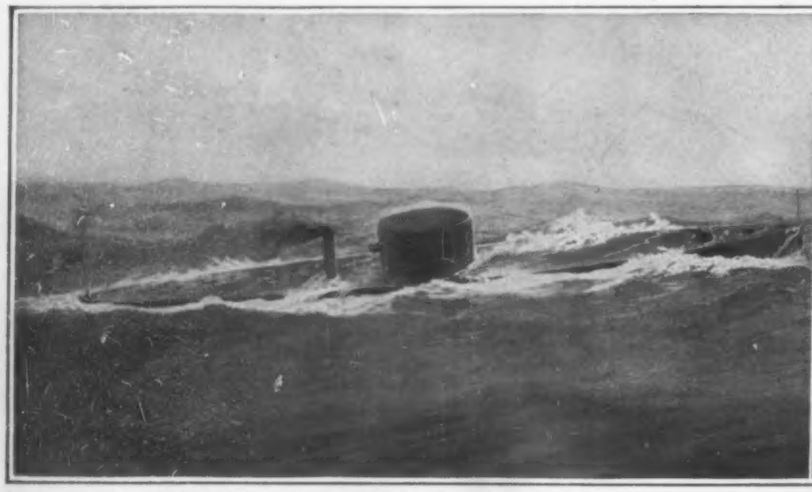
The next illustration in order is that of one of the ships of the Spanish Armada, which sailed toward the close of the sixteenth century. Here we note, as compared with the French vessel of the middle of the 14th century, that a third mast has been added and that the fore and main masts have grown in height until they carry topsails and even to'-gallant sails. The crude cannon of that day of low power and short range are carried on two decks, and it will be noted that the above water ramming stem head of the early days of the warship still survives in the huge stem piece with its super-incumbent dragon.

Once the oar had given place to the sail, and the bow and arrow to the gun, the line of development was obvious, and ships of the seventeenth and eighteenth century grew steadily in size and sail power until they reached the great three-deckers of the Nelson period. The largest of these craft carried as many as 120 to 130 guns. One of our illustrations shows the "Victory," Nelson's flagship at the battle of Trafalgar, as she must have appeared when under sail.

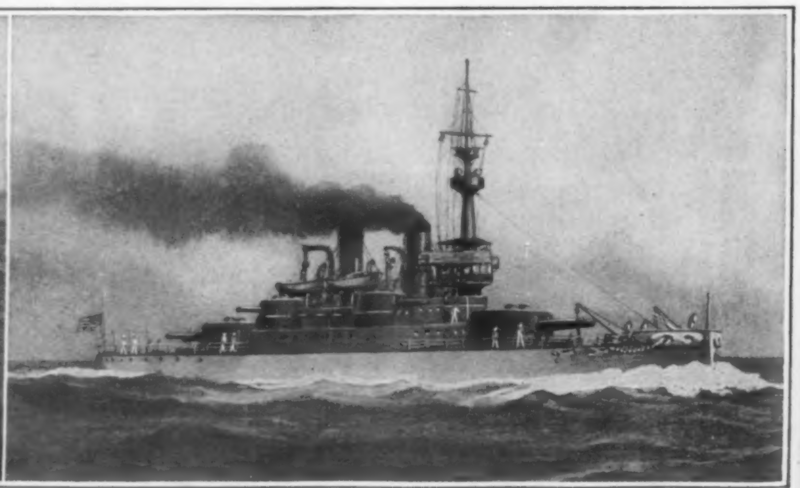
The wooden sailing ship held its own until the second half of the nineteenth century. The first radical change began with the introduction of steam as an auxiliary to sail power, and the steam frigates of which our own "Hartford" is a conspicuous example, held sway as the most formidable type of fighting ships for many years, and figured largely in the naval operations of our Civil War.

Too much stress cannot be laid upon the introduction by Ericsson of the monitor—a vessel of steel with a low freeboard of a foot or two, with nothing above deck but a single armored turret with a couple of heavy guns. A few years before the appearance of the monitor, the French had plated the sides of their steam frigates with iron, and it is the ultimate plating of the monitor and the iron-plated frigate, together with the development in naval marine engines and the power of the gun, that led up to the development of the modern armor-plated battleship, a notable example of which is our own "Oregon." In this ship we have the heavy, 18-inch side armor plate, the heavily plated turret, and the guns carried entirely behind armor. The freeboard has been raised to 13 feet, in order to give seaworthiness. This brings us to the year 1895.

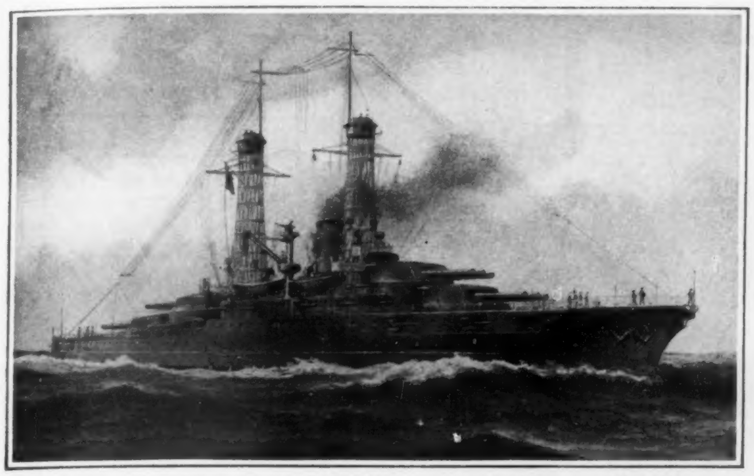
The final step in the development of the fighting ship was the introduction by the British of the dreadnought, in which the mixed battery of 12-inch, 8-inch and 6-inch guns was abandoned, and a single caliber of 12 inches



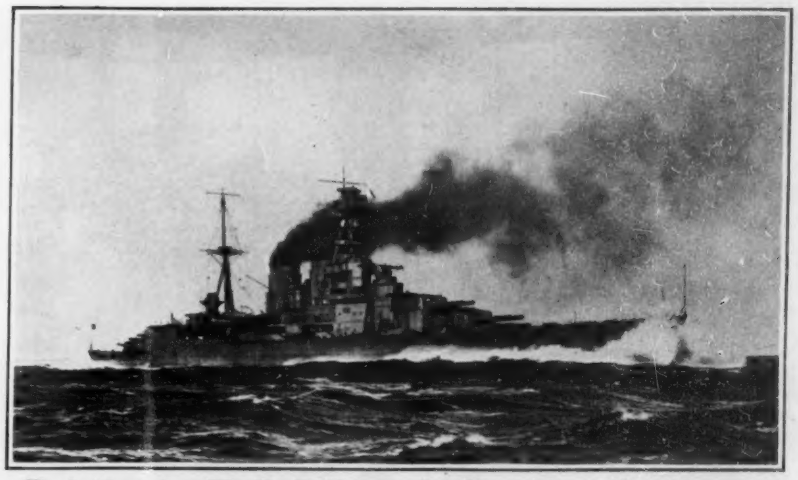
Ericsson's monitor, introducing the armored turret



Battleship "Oregon"; moderate freeboard and heavy armor



The dreadnought "Pennsylvania," 32,000 tons; speed 21 knots; 13"-18" armor; Twelve 14" guns



The battle-cruiser "Hood"; 42,000 tons. Speed on trial, as pictured here, 32 knots; 12"-15" armor; eight 15" guns

was substituted, with a few small anti-torpedo-boat guns. The Dreadnought was a ship of about 17,500 tons displacement, 21 knots speed, 11 inches of armor, and she mounted ten 12-inch guns. From that time on the development has been in the direction of increasing the caliber of the gun, thickening the armor and increasing the steaming radius, and providing cellular compartments along the sides as a protection against the submarine. The "Pennsylvania" may be taken as a good example of the highest development of the modern fighting ship. She carries twelve 14-inch guns behind 18 inches of armor, and is protected by 13½ inches of armor at the water line. Her speed is 21 knots.

A new type has been developed by the British during the war which may or may not become permanent, and this is the "Hood," a vessel 860 feet in length over-all, of 42,000 tons displacement and mounting eight 15-inch guns, the ship being protected by twelve inches of face-hardened armor. A remarkable feature about this vessel is the fact that this heavy gun power, armor protection and great size are associated with a speed of 32 knots.

A New Engine Fuel

At the meeting of the Society of German Chemists recently held at Stuttgart, Dr. Schrauth, private lecturer at the University of Berlin, made an interesting communication on a remarkable new engine fuel derived from naphthaline. German engineers are, under present economical conditions, anxious to find new sources of engine fuel in the home supply of raw materials. Though the use of naphthaline had even in pre-war times been suggested, endeavors made in this connection had so far failed to give any positive results on account of the high melting point of that material, solid at ordinary temperatures, as well as of the complicated preheating devices required to melt and gasify it.

According to the new process made known at the meeting, naphthaline is by chemical means converted into a new liquid compound, bearing the somewhat comprehensive name of Tetra-hydronaphthaline, but termed Tetraline for the sake of shortness, which has proved to be a surprisingly satisfactory engine fuel.

The new fuel is a liquid clear as water, of the specific weight .975, having its boiling point at 205 deg. Cent. and the constancy of which at low temperatures, on account of its low freezing point (-30 deg. Cent.), compares favorably with that of benzol. The high boiling point and a flash point lying at 78 deg. Cent. make tetraline an especially desirable fuel for the high-compression internal compression engines constituting the ultimate goal of present tendencies in engine construction, its high heating value (11,600 calories/kg. as a minimum) insuring a remarkably high output in a limited space, such as neither gasoline nor benzol would allow.

However, tetraline can as well be used in present engine types designed for petrol and gasoline operation, by mixing it with materials boiling at lower temperatures, and thus securing a ready starting, ease of control and smooth running of the engine. Thanks to an addition of gasoline, the specific weight of tetraline is reduced to a figure intermediary between those of engine gasoline and benzol, thus doing away with the necessity of any material alteration of existing carburetors.

Comprehensive tests at the Internal Combustion Engine and Motor Car Testing Laboratory of the Berlin Technical High School have shown a mixture of 1 part by weight of tetraline and 1 part by weight of the usual engine gasoline to give the most satisfactory results (approximately equivalent to those obtainable with benzol). When lighter gasoline is used, the percentage of tetraline can be augmented, thus insuring even better performances. Similar results are observed when using benzol in the place of gasoline as additional fuel, when apart from the advantages above referred to (especially an extreme ease of starting), a greater increase of energy in the fuel tank is obtained.

The well-known expert, Wa. Ostwald, has made extensive tests on such tetraline-benzol mixtures, about which he writes as follows: "A mixture of equal parts of tetraline and benzol constitutes a remarkably good engine fuel, readily starting and burning without any hitch. No alteration of existing nozzles is required. The fuel has a high energy capacity, yielding a high number of kilometers per liter. No difficulties of any kind have been experienced."—By *Dr. A. Gradenwitz.*

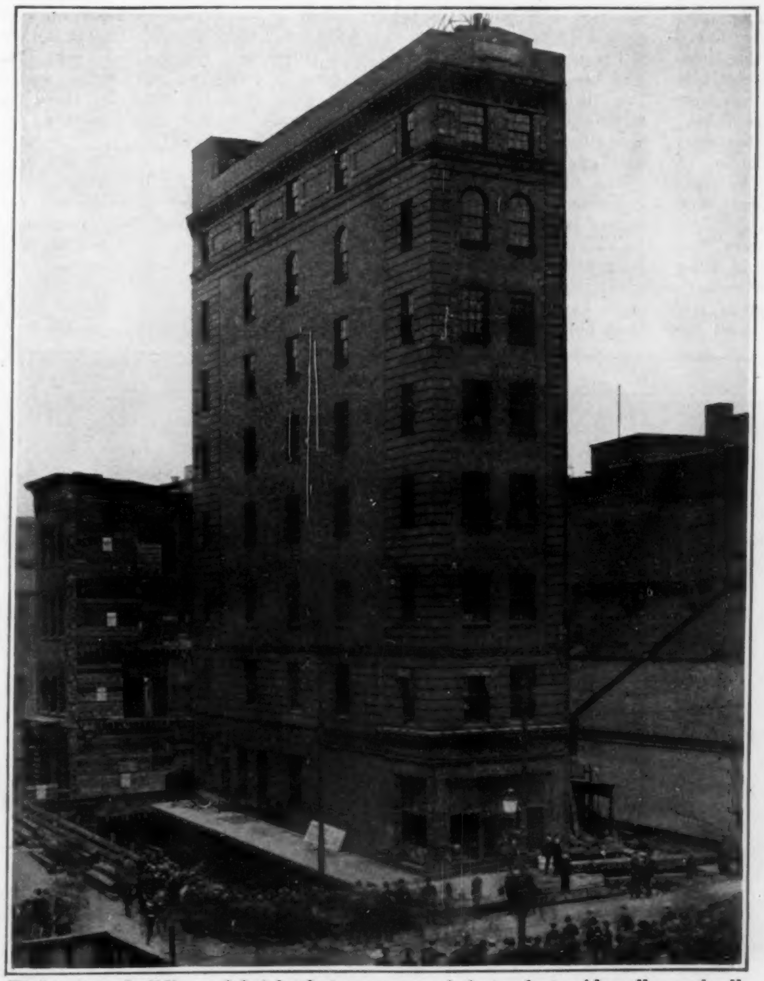
Business as Usual While Moving

Within a comparatively short space memory can carry us back to a time when a house-moving job of any sort was an undertaking of considerable note. Today the ordinary dwelling is shunted about from one place to another, moved across half the town, turned around, and otherwise treated as though its transportability were equal to that of the big truck that does the hauling.

The only possible kind of house-moving undertaking that gets anybody excited in the present generation is one that our fathers would have branded, without argument, as utterly impossible.

One of the most ticklish jobs of the sort we have seen is illustrated on this page. The brick building is always the bane of the house-mover—there are so many places where it can break apart, so many different courses that a dangerous crack, once started, may pursue. Nevertheless, brick buildings are moved with considerable confidence—as the picture shows. This structure was in the swath that was being cleared in connection with the widening of Second Ave., Pittsburgh. It was eight stories high, and it housed a busy business. It was decided to save the building by shunting it back forty feet on to a new site. But what of the business? Logically it might seem that this ought to move out pending the shifting of the building. But there was no place to move to, so it was decided to move the business along with the building. So that was the arrangement made with the contractor—and at every moment of the long-drawn-out moving job the offices and storerooms in the structure were on a basis of "business as usual."

Gas, water, sewer, electric light, steam heat and power for the elevator, and telephone connections were maintained at all times. An elevator running in a moving building is perhaps something really new under the sun. Another curious feature was that the reinforced concrete sidewalks, being part of the building and necessary to cover the cellar extension under the new site as well as under the old, were supported by beams attached to the steel frame of the building and moved along with the rest of the establishment. The building was raised twelve inches, moved forty feet, and deposited on its new foundations without a hitch. The feat attracted no little attention in Pittsburgh, the crowds making the task still more difficult.



Eight-story building of brick that was moved forty feet, sidewalks and all, without any interruption to the business

Structurally, the American airplane is as safe as it is humanly possible to make a flying machine. Its wings are tested with sand bags, as shown in this view, so as to apply a load or strain many times that encountered in all kinds of flying. The factor of safety runs very high

Can the Airplane Be Made Safe?

Why Airplane Fatalities Take Place and What Is Being Done to Make Flying Safe

By Harry A. Mount

THE biggest and most important problem confronting the pioneers in commercial aviation is to make flying safe. For, in spite of all that has been said and done to prove the contrary fact, flying today is not safe. This statement, however, needs to be qualified, for the term "safe" is a relative one.

A number of disastrous accidents have taken place in the past few months, as we all know. And these selfsame accidents have served, perhaps more than anything that has yet occurred, to warn the layman of the dangers of flight. The owner of six flying fields from which hundreds of passengers weekly have been carried on aerial sight-seeing trips, is authority for the statement that these fields and others have been practically deserted in the past few months, so profound has been the effect of these accidents on the average individual.

Now no known method of transportation is absolutely safe, whether by rail, by boat, or by automobile. A man takes a chance with life and limb when he steps on board a street car. But the chance of accident is so small that he rarely gives the matter a thought.

Admittedly, flying is dangerous; but just how dangerous? Probably the extent of the danger is exaggerated in the popular mind. A statement recently issued by the Manufacturers Aircraft Association, covering the period of six months ending July 1—and this includes part of the recent series of serious accidents—showed that the 1200 commercial aircraft operating in the United States flew approximately 3,250,000 miles, and that as a result fifteen persons were killed and 43 were injured in 27 serious accidents. Eight of the fatalities and 32 of the injuries the statement blames on lack of terminal facilities, of air routes, and of storm warnings, or to reckless stunt flying—all of which could have been prevented had there been a national air policy. Deducting these preventable casualties, there was one death for each 464,285 miles flown and one injury for each 295,454 miles flown.

Yet that is not safe enough. It means that in making a trip of a hundred miles by plane a man takes a chance of less than one in 500 that he will not arrive at his destination alive, and double that chance that he will be injured. It means that of every five hundred passengers (or less) carried, one will be killed and two injured. If the railroads maintained any such casualty rate, they would kill off their entire force of engineers every few months. The airplane must compete with the railroads in the commercial field, and to do so successfully a trip by air must approach the degree of safety that the railroad affords.

Happily, a critical review of the facts upon which the figures quoted above are based shows that they make the worst of a bad situation. Of the 1200 aircraft included in the report, about 1000 are operated under the supervision of responsible manufacturers or transportation companies. The other 200 come under the classification of "gypsy flyers." Many of the planes operated by responsible organizations and practically all of the "gypsy flyers" are war machines converted to commercial purposes. They are not as safe as it is possible to build planes today. Most of the accidents have occurred among the two hundred "gypsy flyers."

The risk to aircraft arises from three main sources, and the preventive work being done is following the three broad channels these suggest, viz.: first, the construction and air-worthiness of the craft; second, the operating personnel, and third, the landing facilities and organization.

The first is a problem for the manufacturer, for it concerns the mechanism itself. So high a factor of safety is maintained by all the large airplane makers in this country and so far has the science of design progressed, that any up-to-date standard make of plane, given proper care and inspection, may be depended upon absolutely not to fail in the air. This, of course, does not apply to rebuilt war machines or those which are not properly cared for in their regular service.

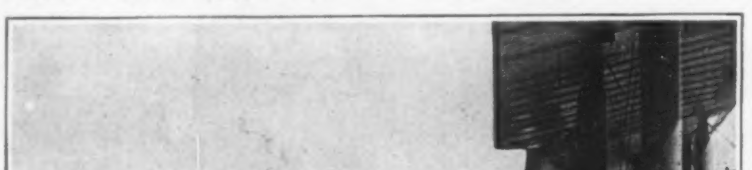
In the matter of motors, however, there is a very different situation. The motor is the "sore spot" of the machine, mechanically. Present-day aviation motors are wonders in reliability compared to those in use a few years ago, but the best of them still are unreliable. A pilot can never tell when his motor is going to "quit on him," and he never feels entirely safe, therefore, unless he is within gliding distance of a landing field. The difficulty seems to be that the high speed internal combustion engine is basically unreliable. There are a large number of rapidly moving parts, some exposed to very high temperatures, which cannot be dispensed with; and there is always the danger of failure in one of these parts which will put the motor out of commission.

Two things are being done to lessen this danger. Motors are being built heavier than the war motors. This does not mean, however, that the machines are less efficient, for so far it has been possible to make a corresponding saving in weight in the airplane. The danger of motor failure is lessened in a large plane by a multiplicity of motors. Most of the two-motored ships are able to fly with one motor "dead." There are also under experiment various schemes for gearing several motors to a single propeller, so that one or more of the motors can be operated at one time while others are held idle as a reserve. The added weight and unreliability of gears, however, has been against this scheme. Two manufacturers have expressed the hope to the writer that the steam engine can be brought to a state of perfection so that it can replace the internal combustion engine on aircraft. There is said to be at least one promising experiment along this line being conducted in this country.

Of safety devices only one holds promise that it will add much to the safety of air passengers, and that is the parachute. Perhaps the average man does not relish the idea of stepping off into space with a little silken bag to save his life. But, as a last resort, he would do it, and the chances that he will live to tell of his experience are greater by far than if he were dropped in the middle of the Atlantic from a sinking ship with a life preserver about him.

Stabilizers have been developed so that they can fly a machine on a straight line without aid from the pilot. But this is merely an aid to the flyer rather than a safety device. For if the pilot is incapacitated in the air there is no way to land safely, even though the machine may be kept in the air safely for a time.

The element of risk from inefficient per-



The parachute is to the aviator of today what the life preserver is to the marine traveler. And the chances of safety with the parachute are many times greater than those with a life preserver

sonnel is not important. Accidents rarely happen because the flyer or his assistants are incompetent. The fact that many accidents happen because the pilot takes foolish chances ought rather to be attributed to the third source of risk—to defects in organization.

It is in this third class of risks—landing fields and organization—that there is room for great improvement and in which there is the promise of quick results. The development of landing fields will of course be slow—just as slow as the development of commercial aviation. In all the United States there are now only 214 adequate municipal or civilian air ports, yet terminals are as necessary to aerial transportation as they are to shipping or railways. Every added flying field is an added factor of safety to commercial aviation: it reduces the chance that in an emergency a plane will have to land in a fence corner or a highway.

The parachute has done much to make flying safer. While it is not the most pleasant sensation to step out into space and depend on a little silk bag, it is better than being dashed to death

So far, this country has lagged behind all other important nations, in failing to provide national air laws. Those few States or communities which have attempted local legislation on the subject have found it difficult or impossible to enforce their regulations.

There has been no way to stop such dangerous practices as flying unsafe machines, flying without the pilot having proper training, flying over crowds, dangerous stunting with passengers, and so on.

In a recent conference with Secretary of Commerce Hoover, representatives of commercial and civil aviation received the definite assurance that a law providing a registration system and a code of air traffic laws would be drawn and presented to Congress at the first opportunity.

A second step in this direction, and a very important one, has just been taken by the Underwriters' Laboratories. The actual and prospective developments in the use of aircraft in transportation of both freight and passengers have created a demand for insurance protection for the capital invested. This demand is now being met by certain insurance companies, and the organization of aircraft departments is being seriously considered by others, for it is foreseen that aircraft insurance will become of large importance.

Analysis of the problems encountered by the aircraft underwriter has been undertaken by the Underwriters' Laboratories under the supervision of Vice-President A. R. Small. The importance of this development lies in the fact that Mr. Small and his associates have devised a registration scheme for both pilots and aircraft and presumably no airplane can now be insured until the rules laid down under this registration system have been complied with.

It is expected this system will prevent the issuance of insurance on a craft unsafe mechanically, which is driven by a pilot not fully qualified, or which is subject to too great risk from any other cause. An airplane is too costly to operate on a commercial scale without insurance and it is believed this step will have the effect of materially reducing the chances of accident and therefore the number of accidents. In Europe commercial aviation is heavily subsidized by the governments, while in this country it must "stand on its own legs" and must pay its own way. This makes the stand of the insurance companies doubly effective.

In closing it ought to be noted that one of the largest benefits to be derived from such cooperative enterprises will be from a system of weather signals, and instructions to flyers while in the air, which have been rendered possible through the development of the directional wireless and the wireless telephone.

The Dissymmetry of the Body and Its Striking Results

WERE you ever lost in a London fog or a driving snowstorm, or even in a tract of dense woods? If so, you probably experienced the usual annoying result of finding yourself walking in a circle in spite of all your efforts to follow a straight line. Physiologists have studied this curious phenomenon and come to the conclusion that it is due to the fact of the difference which always exists between the two lateral halves of the body, and which causes one of them to show a constant though unconscious tendency to exert a pressure upon the other. Some recent experiments in Vienna have thrown further light upon this difference between the two sides of the body and its effects. It was found that in spite of all orders to the contrary persons walking on foot showed a constant tendency to turn to the right, so that a definite effort of the will was required in order to turn to the left. The famous German physiologist, Professor Abderhalden, became interested in this question and investigated it further in the Physiological Institute at Halle. In this building there are two similar stairways, one running to the left and the other to the right, and both placed at right angles to a short flight of steps at the entrance. Observations showed that by far the greater number of students in the building regularly took the right-hand staircase when they come to choose. Inquiry proved, however, that left-handed students, with few exceptions, made use of the left staircase.

The same results were observed in the case of the general public as well as in that of the students. When the stairs were descended, however, there was practically an equal use of the two sets of steps. This is doubtless due to the fact that much more effort is required to ascend a stairway than to descend it.

Prolonging the Life of Insects by Variable Temperatures

SOME very curious experiments have recently been conducted by M. Louis Déstouches, with respect to the possibility of prolonging life in butterflies and caterpillars. The insects used were specimens of the *Galleria mellonella*. The entire evolution of caterpillars of this species ordinarily required a period of about two weeks at the optimum temperature of 37 deg. Cent. According to the *Bibliothèque Universelle*, Lausanne, for June, 1921, a lowering of the temperature retards the development, 15 days being required at a temperature of 34 deg. Cent. and 25 days at 27 deg. Cent. At a temperature below 17 deg. Cent. the caterpillar rarely undergoes a transformation into a butterfly; on the other hand, it continues to live for two or three months, though it appears more or less enfeebled. Between 10 deg. Cent. and 4 deg. Cent. it ceases to eat and even to move and perishes at the end of the month. Strange to say, however, at a temperature still lower, namely, from 4 deg. Cent. to 2 deg. Cent. the vital processes are so much retarded that it lives for six months, undergoing a loss in weight during this time of only a few milligrams—but if the temperature be then raised to the optimum, it takes up the interrupted course of its development.

The experimenter subjected the caterpillars to two alternating temperatures, 1 deg. Cent. and 37 deg. Cent., each exposure lasting for 24 hours at a time. Under these conditions 25 days were required for development. But it was observed that this prolonged period of development exerted no influence either upon the length of life or the activity of the resultant butterfly. In other words, the vital activities of the caterpillar may be retarded by cold without affecting the vitality of the butterfly, a point of great interest to entomologists, agriculturists and horticulturists, as well as to the general scientist.

Furthermore, it was observed that when butterflies are subjected to alternating temperatures the length of their active life is vastly prolonged and they also become more prolific. Under such conditions instead of dying at the end of six or eight days they live for more than a month (30 to 35 days), while instead of laying 10 or 15 eggs they lay from 25 to 35. This is really startling, since it implies that under certain conditions of variable weather, which is a common enough occurrence in many climates, an alternation of temperature between 37 deg. Cent. and 1 deg. Cent. will cause butterflies to live five times as long as usual and to produce at least twice as many as they commonly do of their voracious offspring.

The wonder of it is that the number of airplane accidents is so small. Machines such as the one here shown—old, discarded war-time airplanes—have been bought and reassembled by inexperienced hands and then used in actual flying

Grouping Our Power Plants

The Superpower Survey's Impressive Figures, Which Afford Plenty of Food for Thought

By Robert G. Skerrett

THE recently completed Superpower Survey reveals one phase of our national wastefulness, and, incidentally, shows how much more we shall have to pay for motive energy in the course of the next few years unless we mend our ways. Conversely, this impressively illuminating investigation brings to light that it is possible for us greatly to amplify our power resources and yet effect an annual saving of more than half a billion dollars!

But the story of potential economies is a longer one. The experts have disclosed that we can so coordinate existing steam electric and hydroelectric plants that, in combination with others to be built, it would be practicable to obviate the mining and the transportation of 50,000,000 tons of coal yearly! Or, if the demand develops, this measure of fuel can be supplied to sections of the country lying outside of the proposed Superpower Zone, benefiting those regions proportionately without augmenting the output of the mines.

At first blush, this whole impressive proposition sounds like a promise of much for nothing. Such is not the case, however, for the establishment of the Superpower zone will entail the expenditure of many hundreds of millions of dollars, in return for which the people will profit to the extent mentioned. This is the assured outcome of engineering efficiency applied on a gigantic scale; and once more we have brought home to us the wonders that can be wrought through the agency of electricity.

The area embraced within the Superpower Zone has been somewhat enlarged since the project was first conceived by William S. Murray nearly two years ago, and now may be described as that territory lying between the 39th and the 44th parallels of latitude and extending inland from the Atlantic seaboard an average distance of 150 miles. Inside of the arbitrary boundary thus established live fully 25,000,000 of the nation's population; and the workers of this bustling section of the Union turn out in value quite 40 per cent of America's manufactured commodities. The purpose of the Superpower System is to make it feasible for this intensified industrial sphere to carry on its vitally important manifold activities with greater ease and to meet unchecked the still heavier tasks of the future. In short, to achieve these ends at a lower unit cost through the medium of a plenty of cheaper electromotive force.

One need not be more than casually familiar with the trend of industry abroad to realize that substantially all of our competitors in the markets of the world are bent upon developing their water-power resources and equally intent upon creating highly efficient steam-electric plants so that electricity can be utilized more widely by their railways and in their shops and factories. The object, of course, is to reduce the consumption of fuel or to get a greater volume of power for every ton of coal burned. The ultimate aim is to lessen manual labor, to increase production through greater dependence upon machinery, and to neutralize the charge for present-day wages. This movement is a menace to America's commercial position, and must be offset by the organization of facilities which shall make us strong enough to hold our own in foreign trade.

The Superpower System has not been planned with an eye single to putting us in shape to sell our wares on favorable terms in alien lands: it is designed to make our domestic life a fuller and a pleasanter one through the innumerable conveniences and comforts that go hand in hand with amplified applications of electricity. It is counted upon to bring town and country into closer touch; to put the rural dweller in some respects on a parity with his city brother; and to enable the trunk lines concerned to move their passengers more expeditiously and to transport greater volumes of profitable freight. It is a matter of common knowledge how heavy a burden the coal consumed by any steam railway lays upon it and what this imposes in the way of a reduction in revenue-making tonnage.

Today, within the proposed Superpower Zone there are operated 315 electric public utilities, the majority of them running independently of one another, a total of 18 railroads, and no fewer than 76,000 industrial establishments that use varying amounts of mechanical energy. This great manufacturing section is not favored like the West Coast States with an abundance of falling waters from which to draw motive force. By 1930 the demands for electric current in the Superpower Zone will total 31,000,000,000 kilowatt-hours, and our existing and prospective hydroelectric stations would not be able to supply more than 21 per cent of this. Two years ago 15 per cent of the total output of the electric utilities was derived from water power. Therefore, it is inevitable that we look to steam-electric plants to furnish the other necessary 79 per cent. This point is purposely emphasized because there is a popular and erroneous belief that hydroelectric developments in the Eastern States would go much further toward satisfying requirements.

Plainly, coal is sure to be the principal power reliance in the area under consideration; and it should be a matter of national congratulation that there are vast deposits of some of the best coal in the country within convenient reach of this gigantic beehive of productive effort. Even so, the primary purpose is to utilize this fuel economically and thus to conserve it for future generations of our people. This end will be attained through engineering skill that will coordinate the hydroelectric and the steam-electric facilities in a way to provide a maximum of energy for a minimum of plant investment and operating expense.

As indicated on the accompanying map of the Superpower Zone, the system will include the erection of master steam-electric stations at tidewater, inland on rivers, etc., and at points within the anthracite coal region wherever an ample supply of condensing water can be counted upon, and these sources of energy will be augmented by hydroelectric power stations in the zone as well as others located outside of it but not too far away to transmit current economically. According to the experts, current at a potential of 220,000 volts can be dispatched over the wires a distance of 350 miles with a loss of not more than 6 per cent. This shows how long gaps can be spanned effectively and generating stations and users brought in a sense close together although actually remote.

Manifestly, the proposed new steam-electric superpower stations are to be set up where it will be practicable to secure the full benefits of low freight rates, and to take advantage of railway routes permitting short runs and easy delivery of coal. To be more specific, it is recommended that one of these steam-electric plants be constructed near Pittston, Pa., to furnish a part of its energy to the contiguous anthracite region and the rest of its output to the Metropolitan zone—especially the New Jersey section of the latter. Another giant steam-electric central station is contemplated close to Sunbury, Pa., which will also feed power to the anthracite region, send a portion of its current to the load center at Reading, and transmit the balance of its electromotive force to Philadelphia.

Near tidewater a master steam-electric powerhouse is urged in the neighborhood of Boston to meet the electrical needs of that load center and also the industrial demands of Lowell and Newburyport; and for the load centers of New Haven, Bridgeport, Waterbury, and Hartford there should be provided another big steam-electric plant to take care of that part of the country. All of the foregoing promise to give the quickest returns from the very beginning of the Superpower System; and it is furthermore planned to call into being, in the order named, the following prime hydroelectric installations: Plants on the Delaware and the Susquehanna Rivers for the purpose of supplementing the steam-electric stations at Pittston and Sunbury; the progressive development of the Hudson River projects to meet the growth of energy requirements in the load centers at Schenectady, Utica, Poughkeepsie, and Pittsfield; and to take the first step in the Potomac River developments as soon as the demands of the Baltimore and the Washington load centers exceed the capacity of existing facilities.

It should be evident that the proponents of the Superpower Zone offer a scheme susceptible of gradual evolution, and in laying it out they have looked ahead and taken into consideration the territory's probable power needs nine years hence. We are told that had a Superpower System been available in the region under discussion two years ago there would then have been twenty economic load centers to which its energy would have been furnished. On the other hand, by 1930, if the scheme be carried out as proposed, there will be no fewer than thirty-five of these load centers.

In order to prevent confusion, let it be remarked that the Superpower project logically divides itself into three broad divisions, dealing, respectively, with the electric public utilities, the heavy traction railroads, and the manufacturing industries. It would be well to touch upon each of these in turn. For the past decade the load growth of the electric public utilities has increased at the rate of 11 per cent per annum. Today the yearly demand amounts to 12,321,000,000 kilowatt-hours; and if we assume an increment every twelvemonth for the next nine years of only 9 per cent the electric utilities will be called upon to supply 26,000,000,000 kilowatt-hours in 1930. This can be done efficiently and economically in but one way—by coordinating the existing plants so that they may cooperate throughout the length and breadth of the Superpower Zone with the superpower stations in generating and distributing electrical energy wherever it may be wanted.

For instance, the peak loads for the Anthracite and Mohawk-Hudson Divisions occur in the morning. The peak loads for the other divisions come along in the afternoon; and the annual peak load for the entire Superpower Zone reaches its climax about five o'clock in the afternoon—the heaviest concerted burden being laid upon the power plants usually in December. Clearly, then, this shifting demand can be met successfully with a minimum of equipment only through a give-and-take service among the associated powerhouses.

The base load steam-electric stations conceived by the experts of the Superpower Survey will range from 60,000 kilowatts to 300,000 kilowatts; and the proposal is to install no turbo-generator units of less than 30,000 kilowatt capacity in any of these master plants. The reason for this is that experience has proved conclusively that large units can produce power more cheaply than small ones. For example, the cost of fuel at stations of more than 100,000 kilowatt capacity, for a given volume of energy, is only one-third of that of one of less than 1000 kilowatts, while the maintenance charges of the big establishment average but one-fourth of those of the small powerhouse.

Out of 558 electric public utility plants now within the projected Superpower Zone there are but 36 which are equal or greater in capacity than the average-sized station contemplated for the Superpower System up to 1930. Further, out of the 1074 generating units operating inside the boundaries of the zone two years ago—counting only those of 500 kilowatts and upward, there were only about 20 that had a capacity in excess of 30,000 kilowatts. This is a fair indication of the need of betterment in order to bring down the cost of current.

Analyzing the performances in 1919 of 400 steam-electric power stations, the investigators found that the average of the electric utilities within the zone burned 2.73 pounds of coal per kilowatt-hour and called for a heat utilization of 35,800 B.t.u. per kilowatt-hour. In contrast to this, based upon the best up-to-date engineering practices, it is promised that the steam-electric superpower plants will have a fuel rate of not more than 1.41 pounds per kilowatt-hour and that their boilers will do this on a heat utilization of 18,300 B.t.u. per kilowatt-hour—the big base load steam-electric stations running the while at the same annual capacity factor.

Again, the Superpower Survey has brought to light that the disassociated working of the numerous electric public utility plants necessitated, in 1919, a generating capacity 46 per cent greater than the annual peak load; and it seems that the resulting capacity factor did not exceed 26 per cent. Fancy the overhead represented by so much unprofitable machinery. Conversely, we are assured that by 1930 the Superpower System, being able to take advantage of joint reserve apparatus, will get along with a generating capacity but 9 per cent in excess of the annual peak, and that at the same time the coordinated stations will be in a position to raise the yearly revenue-making output to 45 per cent. This will represent a gain of 73 per cent, and the benefits should logically be reflected in the consumers' bills. The annual saving will then reach $239,000,000; and the allied steam-electric public utility plants will do their work with 19,149,000 fewer tons of coal than stations of like aggregate capacity operating independently, as at present.

Density of traffic, as has been explained frequently in the last few years, determines whether or not it is worth while for a steam railroad to adopt electric traction. Within the Superpower Zone there are 36,000 miles of main line, yards, and sidings, and the Survey has disclosed that 19,000 miles of the trackage could

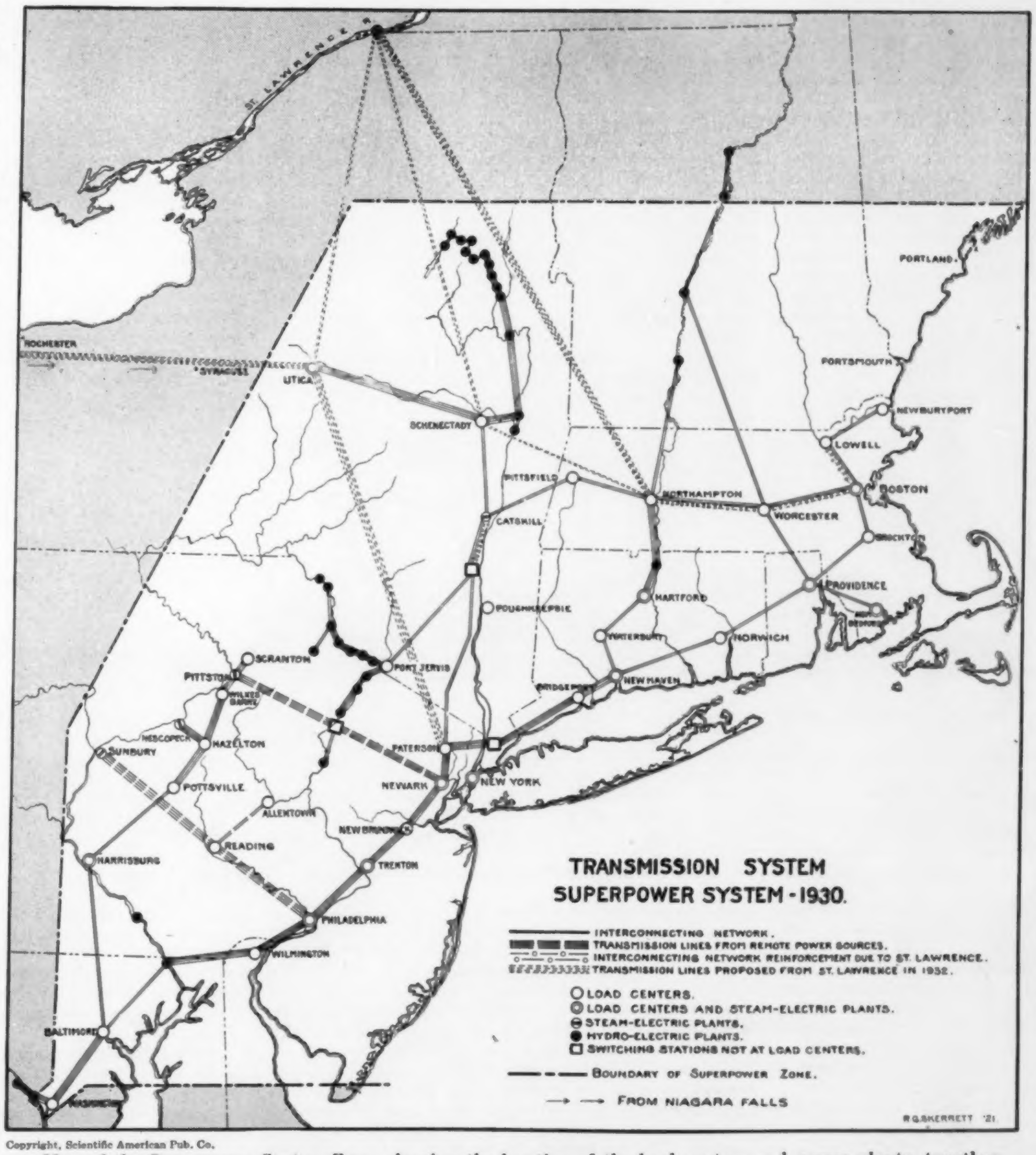
with profit be electrified. This would entail a capital expenditure of $570,000,000, effect a yearly reduction in operating costs of $82,000,000, and yield a revenue of 14.3 per cent on the investment after deducting overhead charges and a liberal rate of interest on the money borrowed to bring about the transformation. It seems unnecessary here to repeat the well-grounded advantages claimed for the substitution of electric haulage.

Mr. William S. Murray, who has been in charge of the Superpower Survey, makes this point in favor of supplanting the steam locomotive on the lines under discussion: "The normal demand for money for extensions and betterments of the railroads within this zone is approximately $150,000,000 annually, an amount which, even in the face of present construction prices, would suffice in three or four years to cover the cost of the entire electrifications mentioned. Should we continue to tinker with an old and defective machine when it is impossible to escape the installation of the modern and efficient one?"

And now for consideration of what the Superpower System will mean to industry within the confines of the zone. Among the 76,000 establishments using power, and which were the subject of study by the technicists of the Survey, there are manufacturing plants, mines, quarries, government shops, and laundries. In short, widely diversified forms of productive activity. The analysis of the data gathered reveals that in 1919 the equivalent of 9,311,440,000 kilowatt-hours was developed by prime movers individual to the industries concerned. The energy purchased amounted to 3,338,800,000 kilowatt-hours. Further, it seems that 4,008,200 horsepower of prime movers might have been shut down to advantage and added energy bought instead to the amount of 5,623,800,000 kilowatt-hours, which would have made a total of 8,962,600,000 kilowatt-hours for 1919. Had power been thus secured in this measure, the saving in coal would have aggregated 13,502,100 tons, or 71 per cent of the coal which was used for the production of energy. The Survey has established the fact that it would be in the direction of economy if all industrial establishments requiring 500 horsepower or less went into the market for their energy. It is only when the service demands rise above 500 horsepower and involve at the same time some special applications for heat that an isolated plant is justified. Even then, it seems that there should be central-station connections in order to provide against irregularities of load.

Any considerable improvement in the efficiency of power production by isolated plants is limited because of the necessarily small average amount of machine capacity involved. While we are assured that the power needs for industry within the zone have been studied on a conservative basis, yet it appears that it will be possible in 1930 for our shops, factories, etc., to effect a twelvemonth saving of $190,000,000. This can be achieved despite the fixed charges against an investment of $185,000,000 for the motor equipment that must be installed in them to receive energy from the Superpower System.

Taking it by and far, little if any comprehensive knowledge has heretofore existed among power users and electric public utilities regarding the growing demand for energy in the different sections embraced by the proposed Superpower Zone, and there has been a corresponding lack of grasp of what these changes would portend economically if met by properly coordinated, interrelated power plants. The Survey has given this matter careful consideration, and has planned accordingly for the location of its big central stations. The load factor for the entire zone has risen from 34 per cent in 1910 to 39 per cent in 1919. Some geographic divisions, such as the Metropolitan, show but very little increase in load factor, while in others, the Southern Division for instance, the expansion has been from 33 per cent to 43 per cent—the augmented loads being largely due to additional industrial demands in those districts.



Map of the Superpower System Zone, showing the location of the load centers and power plants, together with the arrangement of the transmission network

In four years, *i.e.*, by 1925, 50 per cent of the total generating capacity for superpower operation will be centered in plants owned by the present electric utilities, and they will produce about 26 per cent of the energy. By 1930 the generating figure will drop to 39 per cent and the plants will furnish only 18 per cent of the total output—in other words, their principal use will be to take care of peak loads. The heavy base loads will be carried by the master stations, to be built as distinctive features of the Superpower System.

The Survey has shown that in 1919 the electric public utility plants within the zone, both water power and steam driven, had equipment averaging 7900 kilowatts per plant. Per kilowatt of capacity the master will have increased to 29,900 kilowatts. But even more striking is the potential development in the steam-electric establishments, which will jump in the same period from a mean of 10,000 kilowatts to 218,000 kilowatts per plant. Per kilowatt of capacity the master powerhouses will cost much less to erect and to equip.

To bring this whole subject to a focus let us see what will be the difference in outlay for the Superpower System and the price that would have to be paid for a commensurate amount of energy developed agreeably to present-day practice among the independent electric public utilities. The new money required for the Superpower System by 1930 is put at $693,218,000. This is an immense sum, but it is less by $163,000,000 than the amount that would have to be spent for the proper development of the prevailing disassociated electric utilities.

So far the steam-power plants and the hydroelectric ones have been considered separately. Much can be gained, however, by bringing the two sources of energy together. The Superpower Survey report discloses that an economic combination of steam and water power installations can be made which, with an increased investment of $44,838,000, will yield a return annually of $69,550,000. Here we see exemplified one of the prime advantages of superpower production: expense being reduced by reason of an interconnecting system which permits of the highest efficiency in the steam stations and of the best or maximum use of the available water power.

The report accepts as a certainty the establishment of hydroelectric plants on the St. Lawrence River and further developments at Niagara Falls, both of which will eventually deliver power to the wires of the Superpower System even though they lie outside of the prescribed zone. These, however, are not likely to be in a position to lend aid to the Superpower System much before 1932. It is estimated that the average cost for St. Lawrence power will then be $.0046 per kilowatt-hour for 600,000 kilowatts, at 80 per cent load factor, delivered at Utica, Schenectady, and Northampton. The total annual outlay for all St. Lawrence power in 1932, transmitted to the load centers of eastern New England, western New England, the Mohawk and the Hudson Divisions will be $130,273,000. If, on the other hand, the excess energy requirement of 1932 over that of 1930 were furnished by new steam-electric plants in the Superpower Zone the charge would aggregate substantially 141,601,000. The St. Lawrence development, therefore, promises to net a yearly saving of $11,328,000 to the sections drawing from it. Finally, the total investment required for purchased St. Lawrence power would be $24,826,000 less than that involved in erecting new steam-electric plants to supply this energy.

The existing transmission systems of the electric utility companies, now consisting of about 1200 miles operating at 33,000 volts or higher, will be distribution rather than transmission circuits when they are eventually linked with the conductors of the Superpower network. In 1930 the Superpower System should be composed of 970 circuit miles of 220,000-volt lines and 4696 circuit miles of 110,000-volt interconnecting wires. When the transmission systems for the St. Lawrence and the Niagara developments are constructed they will add 3140 circuit miles of 220,000-volt lines to the Superpower Zone System.

The New Marine Salvage System

Lifting a Sunken Ship by an Equalized Pull Upon Her Main Frames

WHEN reports came from England that the British had taken up the problem of raising the ships sunk by submarines during the war and that they had been successful in recovering many of these, the hopes of the public were raised to expect almost the impossible. New systems and schemes were being proposed almost every day. Many of these were tried and some of them were found to have merit; but although several hundred ships were salvaged the work has been practically abandoned because it has been found impossible to raise a ship of any considerable size from other than comparatively shallow water.

Most of the valuable ships which had on board extensive cargoes were sunk far enough off shore and in such depth of water, that all methods were found to be inadequate to overcome the difficulties encountered. During stormy weather it was impossible to use surface equipment in the shape of horizontal pontoons, and although many of the ships were raised by lashing other vessels on each side of them to sustain the dead weight of the sunken hull and cargo till the operation of pumping the water from the submerged vessel had been accomplished, a depth of more than about six feet of water over the deck of the sunken ship rendered this operation impracticable, since the structure of the ship was unable to sustain the pressure. Nearly all previous methods have involved either the attaching of cables to the hull of the vessel in such number that the weight of the ship could be overcome by means of some lifting power exerted from the surface, or by means of compressed air forced into such compartments of the vessel as could be made air tight, or by a combination of these two methods.

The work of controlling the surface-lifting devices has always been attended by great danger and uncertainty, owing to the difficulty because of wave motion, tides and current, of maintaining the proper relation between the sunken ship and the equipment. Sudden storms have delayed operations for long periods of time and have often swept away in a few hours the work of months, besides destroying equipment worth many thousands of dollars.

The accompanying drawings show the plans that have been developed by Mr. Jesse W. Reno, of New York, covering apparatus which he claims will overcome all of the difficulties experienced in past salvage operations, and at the same time make it possible to raise ships from greater depths than has ever before been possible. Mr. Reno is a well-known consulting engineer, the inventor of the moving stairway or escalator. His plans, while novel, contain no untried elements. Every essential feature of the equipment has been tried and proved in other lines of work. The application of these principles and equipment is, however, new in its collective application to the raising of ships.

The Reno system consists in the use of a series of multiple-unit, open-bottom vertical pontoons, submerged to the depth at which the sunken vessel lies, and there securely fastened to the hull and filled with air. The work of preparing the hull for the attachment of the pontoons is performed by two operators working within a mobile diving chamber or tractor, which is lowered from the surface to the sea bed where, under its own power, it maneuvers around the ship. The men in the chamber work under ordinary surface conditions, the air being purified and renewed by the same system as is used in submarine boats.

When the sunken vessel has been located the working chamber is lowered to the sea bed by means of a cable. Through the center of this cable runs an electric cable which supplies power to an electric motor within the chamber. Telephone communication is also maintained through this core with the mother ship, so that at all times there is perfect coordination between the men at the bottom and those at the surface. The electric motor drives a pair of twin drills, which when the chamber has been moved to the side of the vessel, drill holes through the plates of the hull, one on each side of, and close to, the frames of the ship, thus affording the strongest possible point at which to attach the pontoons. It should be noted that contrary to popular impression the sea bottom adjacent to the coasts, is not covered with deep mud, but except at the mouth of rivers and some estuaries consists of firm, clean bottom suitable to the operation of such a tractor as is here used.

Two sizes of pontoons are used, one twelve feet in diameter and sixty feet long of 200 tons' lifting capacity and the other twelve feet in diameter and thirty feet long of 100 tons' lifting capacity. The holes are drilled in sets of four or eight, depending on the size of pontoon to be used. The pontoons are built of steel, electrically welded. At a point slightly below the center of buoyancy, within the pontoon, there is welded a circular truss construction, which distributes the strain of the lift to all parts of the pontoon. The attaching cables are mounted on an equalizing lever, so arranged that an equal strain is maintained at all times on each cable in spite of the uneven drilling of the holes, or should there be any movement of the pontoons due to wave motion, after the ship has been brought to the surface. At the lower ends of the cables are standard crane hooks, also mounted in pairs on equalizing levers.

Outside the working chamber, at the rear of the tractor is a long winding drum, controlling two cables spaced about eight feet apart. Attached to these cables is a hollow steel float of sufficient buoyancy to rise to the surface when released, carrying the cables with it. After the necessary number of holes have been drilled in the hull of the vessel the float is released by the operators within the chamber and the float rises to the surface. The float is fitted at the top with a hook and near the bottom of the pontoon is a staple, its position being marked by a line of paint running to the top of the pontoon. Upon the arrival of the float at the surface a diver secures himself to the float and the operators in the working chamber are signaled to pull the float down. When the diver reaches the position of the staple he inserts the hook and rises to the surface. The workers in the chamber are notified and starting the drum in motion they pull the pontoon down to its position of attachment. Sufficient air is maintained in the pontoon during this operation to keep it upright. This is done by means of an electric gage which registers the pull of the winding drum in the chamber and in the operating room of the mother ship.

The insertion of the hooks in the holes is performed by means of an adjusting rod operated by the men in the chamber. After the insertion of the hooks sufficient air is pumped into the pontoon to insure a firm lift and to maintain it in position while the other pontoons are attached by the same method.

The pontoons are towed out to the position of the ship in a horizontal position. Prior to their launching a diaphragm is placed over the open end, the contained air causing them to float high in the water. On arrival at the mother ship this diaphragm is removed and through a valve in the upper end the air is allowed to escape till the pontoon floats in a vertical position and is barely awash.

The pontoons are filled with air by means of a sea-bed siphon, which delivers compressed air from the mother ship to each pontoon in turn. Care is taken in filling the pontoons to maintain an equal distribution of strain and to insure the proper balance of the ship when she rises.

In shallow water, or where the sea is so irregular that the use of the tractor might not be advantageous divers are used to drill the holes using a form of sea-bottom sled on which is mounted the necessary apparatus for performing the operations.

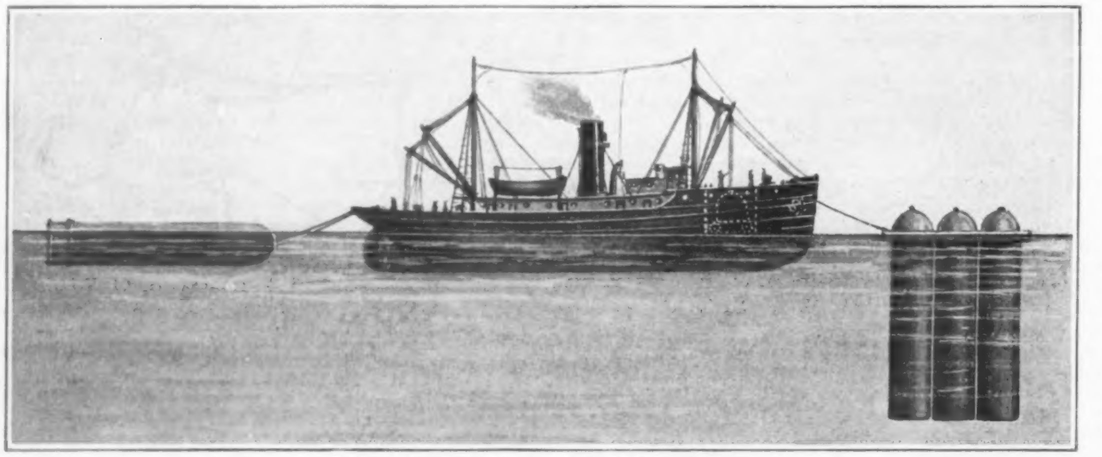
Mr. Reno claims many advantages for his system. Tests made in submarine boat work show that at a depth of more than fifty feet below the surface there is practically no movement of the water due to wave motion, thus enabling all the operations to be carried on in still water. Any slight movement of the water would not affect the operation of attaching the hooks, since the pontoons are hauled down, not lowered, and are under the control of the sea-bottom operators. Should a sudden storm come up the attached pontoons can be left attached to the hull and the working party seek shelter in port. After the subsidence of the storm work can be continued from the point where it had been stopped without any damage having been done.

There is therefore no danger to the workers or to the equipment. The equipment being in units can be used repeatedly, the only question to be decided being the number of units necessary to raise the weight of ship. The use of a great number of pontoons also distributes the strain to many different parts of the ship, so that at no one point is there sufficient strain to cause any damage to the plates or structure of the hull.

Should a ship to be raised be found to be lying on her side, a position which is very rare, the pontoons are first attached below the edge of the deck and enough air pumped in to pull her upright when the usual method will be followed.

After the ship has been raised to the surface, she is towed to a protected position where she can be elevated to a sufficient distance to be towed into port and placed in dry dock. This consists in placing under the ship a series of box-shaped pontoons. The side pontoons are then deflated and drawn down one at a time and hooked along the lower edge of the bottom pontoons, the holes drilled in the ship being then plugged and the side pontoons reinflated. The added buoyancy will raise the ship's deck well above the surface.

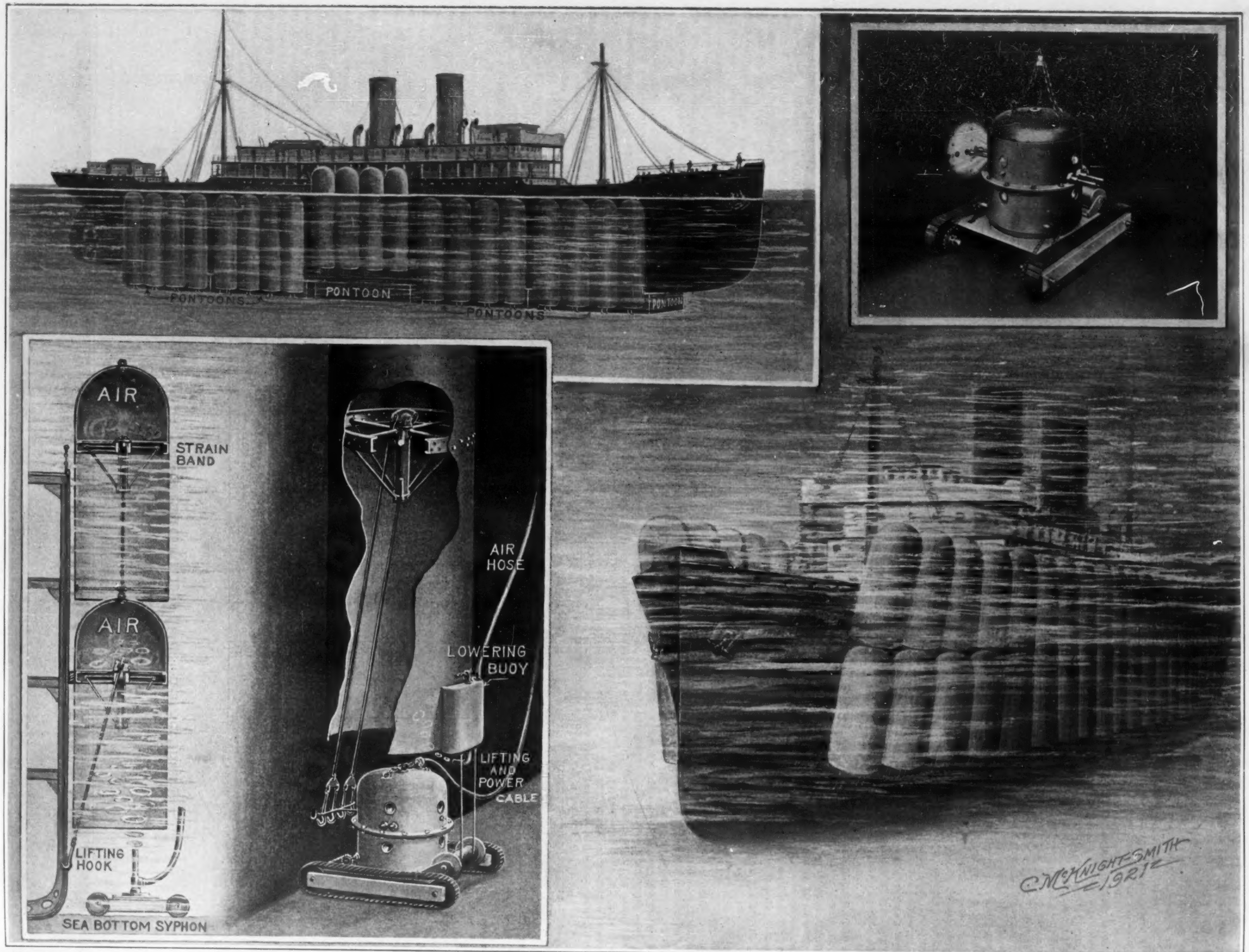
Working under the Reno system the size of the ship to be raised does not militate against the success of the apparatus, as with the vertical pontoon the length of the ship always affords sufficient space along which to assemble enough pontoons to exert the necessary lifting power. In the opinion of prominent engineers who have carefully examined Mr. Reno's plans there is no reason why the equipment should not perform every function claimed for it. In fact the opinion has often been expressed that it is perfectly feasible to raise the "Lusitania," the "Britannic" and other large vessels with the Reno system.



Salvage tender with vertical lifting pontoons

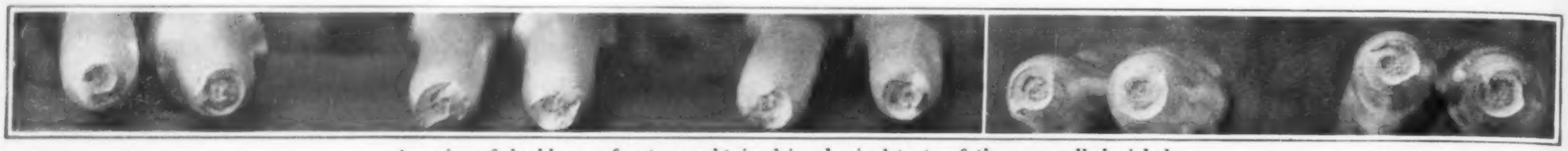
Rain and Radio-Activity

THE interesting question has been raised by a French investigator, M. P. Loisel, as to whether there is any connection between rain and the radioactivity observed in springs. He observed that the radioactivity of the warm baths at Orne is variable. The water of the spring called the *Source des Fées*, which is a cold spring having a temperature of 13 degrees Centigrade, contains radium emanation. This emanation is at its maximum after a rainfall, reaching its highest point from the fifth to the eighth day and the greater the rainfall the greater this maximum.



Left upper: Vessel, after being raised from deep water by vertical pontoons, is given a final lift by horizontal pontoons until her deck is clear of the surface. *Right upper:* Tractor working chamber. *Left lower:* Sectional views of vertical pontoons, showing lifting hooks being guided into holes drilled in vessel, by a T-rod, operated from working chamber; also note sea-bottom syphon through which air is being fed for displacing water in pontoon. *Right lower:* Sunken ship, with pontoons attached.

A new marine salvage system, which makes use of a tractor working chamber and numerous pontoons

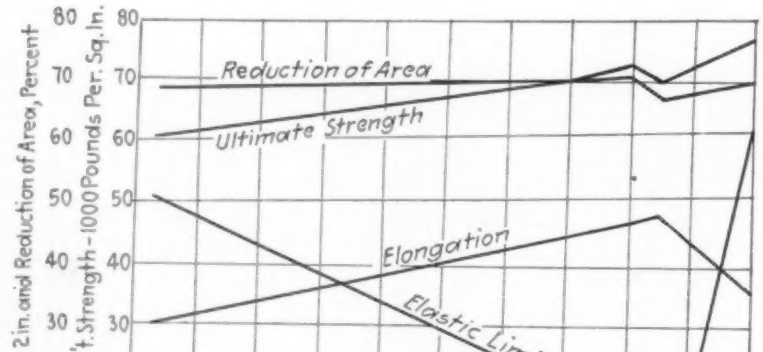


A series of double-cup fractures obtained in physical tests of the new rolled nickel

Rolling Pure Nickel

A Recent Metallurgical Development That Puts This Metal on a New Basis

By A. R. Surface



The physical properties of 99 per cent rolled nickel, at the temperatures to which it is likely to be exposed

WHILE nickel is a malleable metal, its rolling like steel into various forms and its forging have always been regarded as impossible except under difficulties including frequent annealing and other treatments. The rolling of 99-per-cent-pure nickel into the various shapes into which mild steel is rolled is now commercially possible and is an achievement of exceeding interest to the metal working trade. Forgings of this metal are also announced, as well as its fabrication similarly to mild steel. An interesting feature of this new development is that the same apparatus is used for working the nickel as is used for the steel. It is possible to roll steel bars and then immediately to introduce pure nickel billets or ingots into the rolls.

Dr. Charles T. Hennig, who is responsible for this development in nickel products, has experimented for many years in making nickel malleable enough to be rolled or forged into various shapes. He considers that the objects he has sought are now fully attained, though the rolling of pure nickel had long been considered impossible. The company's plant is located at Hyde, a small town in Clearfield County, Pa. It had previously been operated as a rolling mill. In 1916 Dr. Hennig obtained possession of it. After completely rehabilitating it and installing new equipment, he continued the rolling of steel while the development of the commercial production of pure nickel was under way.

Because of the non-corrodibility of pure nickel and its antiseptic properties, those interested predict its extensive use in many industries. It is especially suitable, as insuring easy sterilizing, in dairy machinery of all kinds; in dye house equipment, where acid and alkaline solutions are used; in gas and oil engines, where extremely high temperatures prevail; in marine installations, where parts come in contact with salt water; in pickling and chemical works; in power plants and mining equipment. A large use for it as milk cans is expected. The high scrap value of the metal is an important commercial factor. Unusual strength and durability, affording lighter weights for specified purposes, and the fact that non-corrodibility insures longer usefulness, are cited as offsetting the higher cost.

The new product has great resistance to corrosion caused by acid fumes and acids, by alkalies, superheated steam, etc. It oxidizes little at high temperatures. It can be welded to iron, to steel, or to itself. It is white in color. It has a specific gravity of 8.871 at zero Cent. The average chemical composition shows carbon, 0.025 per cent; phosphorus, 0.015 per cent; sulfur, 0.025 per cent; silicon, 0.155 per cent; copper, 0.12 per cent; iron, 0.6 per cent; manganese, a trace; and nickel (plus cobalt), 99.06 per cent. The melting point is 1485 deg. Cent.

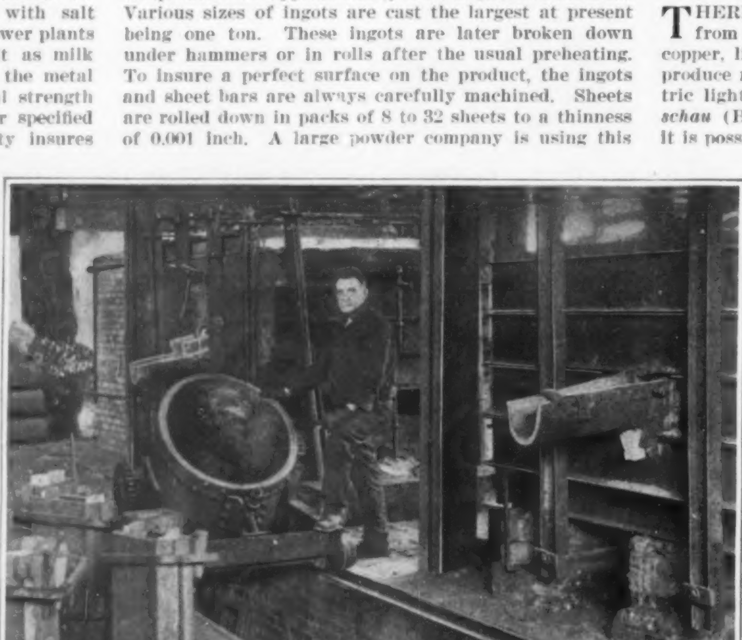
For the crude nickel obtained in the open market as raw material, Dr. Hennig had developed a special treatment preliminary to rolling it into the many shapes produced at the Hyde plant. Striking malleability, under all conditions of heat and cold, has been secured. The writer has seen a 4-inch section of a 1-inch round rolled bar of this metal flattened cold by up-setting under a 2500-pound hammer until it was about 3½ inches in diameter and ⅜-inch thick, with no cracks or seams apparent. Also a 1-inch bar has been forged down hot to about ½ inch and then flattened under the hammer until cold. This was then reheated and folded over on itself and again flattened under the hammer, until there were 128 folds in the resultant piece, which showed only a few evidences of cracks or brittleness. It is Dr. Hennig's claim that this is not possible with ordinary commercial pure nickel.

The raw material is refined and specially treated in small 2- to 3-ton open-hearth furnaces, specially designed by Dr. Hennig. The hot metal is poured into ingot molds such as are used in making steel, at a temperature of approximately 3200 degrees Fahrenheit. Various sizes of ingots are cast the largest at present being one ton. These ingots are later broken down under hammers or in rolls after the usual preheating. To insure a perfect surface on the product, the ingots and sheet bars are always carefully machined. Sheets are rolled down in packs of 8 to 32 sheets to a thinness of 0.001 inch. A large powder company is using this very thin metal in a cartridge for smokeless powder.

The Brinnell value of the hot rolled material is given as 103 and of the cold rolled up to 195. The metal can be bent back on itself without fracture, and it is stated that heat has no effect on the ultimate strength. When heated in air by a blow pipe at a temperature of 1900 degrees Fahrenheit for 3½ hours no scale is formed, and the surface is only slightly tarnished by the heat. It can be heated almost to the melting point without the formation of scale. Among its physical properties the high elastic ratio is noteworthy.

Besides the straight rolled nickel, the company produces nickel-coated steel sheets or other products by rolling nickel sheets in conjunction with steel billets. By placing the nickel on one or both sides of the steel billet or slab the desired product is obtained by welding. It is possible to produce a highly polished nickel-coated steel sheet. Tubes have been produced for service in locomotive boilers, and one railroad has obtained interesting results in such service.

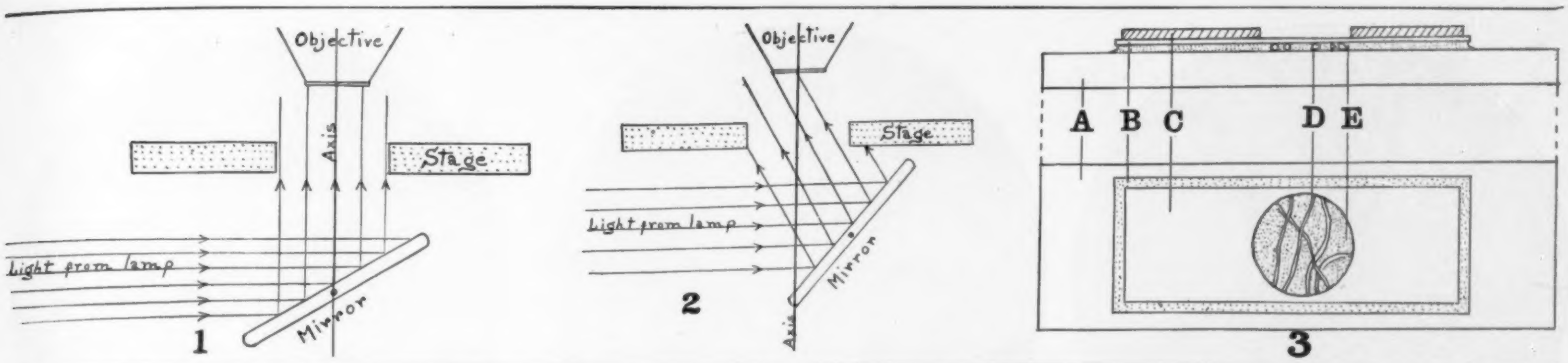
It has been found practically impossible to break sheets of moderate thickness by bending. A sheet 15 feet x 52 inches x 3/16 inch thick is exhibited as the largest that has been made from pure nickel. In the passage through the rolls no scale is given off, and the working of the metal hot is a pleasant sight. The nickel can be quickly annealed by heating to a yellow heat and plunging into cold water. It will then become as soft as copper. If plunged into liquid air it still retains its malleability while copper and some other metals become so brittle that they will disintegrate or become granular.



The open-hearth furnace of special design in which the crude nickel is treated preparatory to rolling

Chemically Pure Nitrogen from the Air

THERE are various processes for obtaining nitrogen from the air, such as passing air over incandescent copper, liquefying air, etc. But these do not suffice to produce nitrogen of sufficient purity to be used in electric lights. A new patent is announced (in *Die Umschau* (Berlin) for Dec. 25, 1920), by means of which it is possible to produce nitrogen having a 99.5 per cent degree of purity directly from the air. For this purpose the oxygen of the air is burned by means of a hydrogen flame and both gases are heated, before being mixed, to the temperature of combustion, in order to ensure complete combustion. This is accomplished by means of a porous partition which is heated to 800 or 900 deg. Cent. One of the two gases is conducted through the pores of this diaphragm by means of which it is heated to the desired temperature, while the other gas is made to reach the same temperature by being led past the furnace. As a general thing the heat liberated by the combustion of the hydrogen is sufficient to maintain the diaphragm at the required temperature, so that it has to be freshly heated only at the beginning of the reaction. The mixture of gases which escapes from the furnace consists almost entirely of nitrogen and water vapor. After the condensation of the latter the gas is passed through a highly heated tube filled with copper oxide and metallic copper, in order to remove traces of oxygen or any excess of hydrogen. This process can also be employed for other purposes, such as the separation of argon from the air or from mixtures containing oxygen.



1. Diagram of the microscope stage, with the mirror set for vertical, or direct transmitted, light. 2. How the stage is set for oblique light. 3. The make-up of the fiber compressor: *A*, slide; *B*, cover glass; *C*, brass rectangle with circular aperture; *D*, fibers; *E*, mounting solution

Sketches showing the construction of the microscope stages and other apparatus employed by the author in the examination of textiles

Fabrics Under the Microscope

Some Methods in the Microscopical Examination of Textile Fibers

By Leon Augustus Hausman, Ph.D.

DURING the past few years the microscopical examination of textile fabrics has been gaining in favor with investigators as a ready and sure means of identification of the stuffs used in weaving and spinning. In a recent contribution to this paper (Hairs That Make Fabrics, Feb. 21, 1920), the writer described some microscopical methods and results in the examination of the commonest mammal hairs used in the textile industry. In this paper it is his aim to recount some of the processes of treatment in the microscopic examination of the vegetable and artificial fibers, which he has found to be the most useful in identifying the materials used, detection of adulterants, and so forth.

The textile fibers of commerce may be divided into four great classes: animal, vegetable, mineral and artificial fibers. The animal fibers, *i.e.*, hair and silk, are essentially nitrogenous in composition, that is to say, are composed of substances classed under the general name of proteids. Animal fibers often contain sulfur, and when burning give out a peculiar, pungent, characteristic empyreumatic odor, by means of which it is often possible to distinguish fabrics of animal from those of vegetable derivation. Alkalis attack animal fibers, causing them to dissolve, or tend to do so, but the action of mineral acids is withstood to a considerable degree.

Plant fibers, on the other hand, lack nitrogenous compounds almost entirely, and are composed of woody material, called cellulose, starchy in nature, and burn readily, giving off little or no odor, and being reduced to a fine whitish ash. Unlike the animal fibers, also, they are readily attacked by such acids as sulfuric and hydrochloric.

Mineral fibers are of rare occurrence in the textile industry, and are confined chiefly to the various kinds of the mineral of the same name. Asbestos, in nature, occurs as a mineral compound of silicate of magnesium and calcium, together with iron, and occasionally with a slight proportion of manganese. Though it is found in a hard state, not unlike feldspar, it can be readily split up and separated into multitudes of whitish or greenish, slender, tough, flexible fibers. Some species of asbestos furnish straight fibers, others curly ones. It is the latter varieties that are chiefly used for spinning.

The artificial fibers are of two sorts: those which are of mineral, or inorganic origin, and those derived from vegetable products. The former group embraces such fibers as spun glass, metallic threads of various kinds, and slag "wool"; the latter comprises the various artificial silks. Spun glass fibers are prepared by various processes which draw out the molten glass into very fine threads which harden at once by reason of their rapid cooling. Glass fibers are sometimes used as the weft of silks, where they impart an unusual heaviness and glancing luster to the cloth. Slag "wool" is prepared by blowing steam strongly through a mass of molten slag, producing a fluffy, wool-like substance. This is little used in spinning, however, and cannot strictly be called a textile material. Its chief use is for packing. Various metals, such as gold, silver, copper, etc., are drawn out into fine threads and used to a considerable extent in working into the designs in heavy brocades, trimmings, passementerie work, embroideries, church vestments, tapestries, etc.

The artificial fibers, strictly so-called, are the various artificial silks, composed of cellulose—the woody material of plants—and prepared, in general, by dissolving this substance in some suitable medium, *e.g.*, ether and alcohol solution, and then forcing it through very fine openings. The thin streams of the solution quickly solidify, due to the rapid evaporation of the solvent medium, leaving behind the delicate threads of cellulose. Because of the glossy, smooth surfaces of these fibers (see Figs. 6, 7, 9) they reflect the light readily and hence assume the lustrous appearance of the true silk fibers.

The microscopic investigation of textile fibers, of all derivations, has in the main been confined to examination under the microscope by what is known as transmitted light, *i.e.*, light reflected from the mirror beneath the stage of the microscope up through the specimen, and thence into the microscope tube. Often the specimen under examination is bathed in oil or water, to render it more transparent, and more easily penetrated and illuminated by the light rays. In the examination of mammal hairs the writer has utilized several other methods of lighting and mounting, which have also yielded excellent results when applied to the study of other textile fibers. These, and the results which they afforded, are here described, in the hope that they may prove useful to microscopists engaged in textile examination.

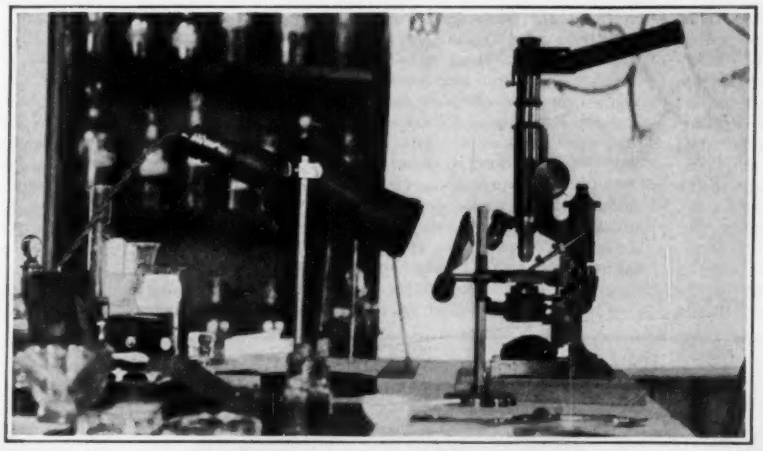


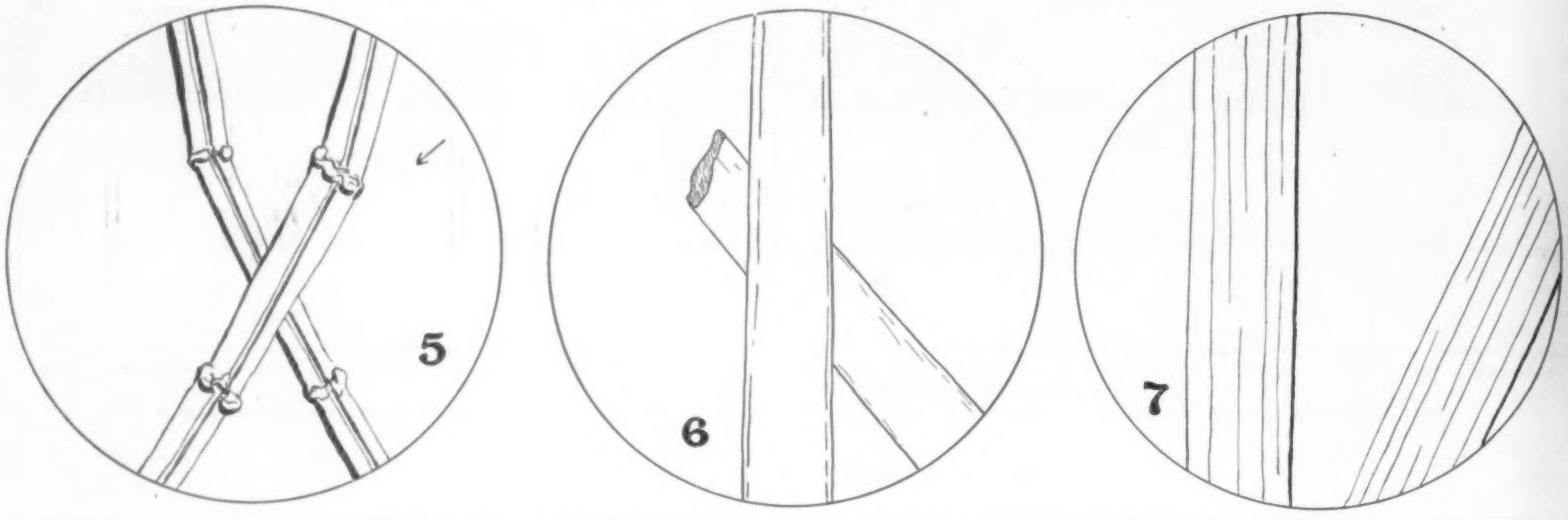
Fig. 4. Microscope, condensing lens (on stand) and microscope lamp arranged for examination of object by dark field illumination, using reflected light. Here the object receives light directed upon it from above

The equipment for the examination of mammal hairs and textile fibers should, for general work, consist of: a good compound microscope, with a triple nosepiece, bearing a 16-millimeter, a 4-millimeter, and a 1.8-millimeter (oil immersion) objective, and being equipped with a complete substage attachment, including a special "paraboloid" condenser, for use in dark field illumination. Furthermore, there should be available for use at least three eyepieces, or oculars, giving different powers of magnification with the different objectives, and an ocular micrometer for micro-measurements. A movable type of microscope lamp is a necessity, fitted with "daylight glass," and provided with other glasses of different colors. A short-focus lens or condenser is convenient, for concentrating the light where it may be needed. There are other microscopical accessories which are convenient, and when once used, apparently indispensable; but the equipment mentioned above will serve all practical needs. The slides and cover-glasses used are of the ordinary sort, and must be kept scrupulously clean. Forceps, dissecting and teasing-out needles, scalpels, scissors, pipettes, and all manner of instrumental accessories can be multiplied *ad libitum*.

The commonest method of examination of textile fibers is with transmitted light. This method gives good results in many cases, and yet does not bring out the delicate striations, or other characteristic markings upon which the identification of many of the fibers depends. In order to render these more clear, staining is often resorted to, yet this also is a more or less rough-and-ready method. Striations, folds, grooves, etc., when lying in a beam of light parallel to the optical axis of the microscope, *i.e.*, parallel to that beam of light which enters the front lens of the objective and leaves the center of the eye lens of the ocular, are often almost wholly invisible. This is not the case when the light from the mirror is oblique with reference to a line from the eye of the observer to the object under examination, so that it illumines the fiber from one side, and causes shadows to be cast by each depression or elevation. Figs. 1 and 2 illustrate the principles of vertical and oblique lighting when applied to the microscope.

Oblique illumination can be modified in various ways to meet different needs. It can be sent into the object on the slide either from the right or from the left, from in back or in front of the stage aperture, and at angles of varying degrees in any of these positions. Colored light from the microscope lamp has sometimes been found useful for demonstrating markings, especially pigment patterns in some of the finer hairs used in weaving. The color and intensity of the illumination, as well as the optimum angle of obliquity of the light rays, are elements which must be worked out empirically for each specimen under observation.

In examining certain fibers which it was desired not to stain, and yet which, because of their uniform hyalinity it was difficult to illumine properly, the writer utilized a device which will be termed a *fiber compressor* (Fig. 3), consisting merely of a rectangular strip of heavy brass, bearing a circular aperture in its center. The fibers designed for examination were placed upon a slide covered with a cover glass, irrigated with a colored liquid, and slightly compressed by placing the brass slide over the cover glass. The result was a group of fibers, showing clearly their outlines against



5. Fibers of linen from the winding sheet of an Egyptian mummy, viewed by oblique light; the arrow indicates the direction in which this fell. 6. American-made artificial silk of cellulose, viewed in safranin solution in the compressor. 7. Italian-made artificial silk, seen under similar conditions

What the microscope shows us of textile fibers from various sources

a background of solid contrasting color. In other words, instead of staining the fibers and examining them against a white field, the field was stained and the colorless fibers examined against it. This method proved very successful with such fibers as some of the artificial silks, where a natural, not a stained, appearance was the end in view. The stains used for the fiber compressor were: a saturated aqueous solution of safranin, of methyl green, of gentian violet, or of Bismarck brown. These were made up and diluted to the required depth of color for each specimen. Figs. 6 and 7 show, respectively, American cellulose acetate silk and Italian-made cellulose zanthate silk, both examined in the fiber compressor in safranin solution. Various excellent differential lightings for bringing out a wide variety of markings in fibers can be had by utilizing the fiber compressor with both transmitted direct, and oblique illumination, and various colors both of the light, and of the "background solution" or mounting medium of the fibers.

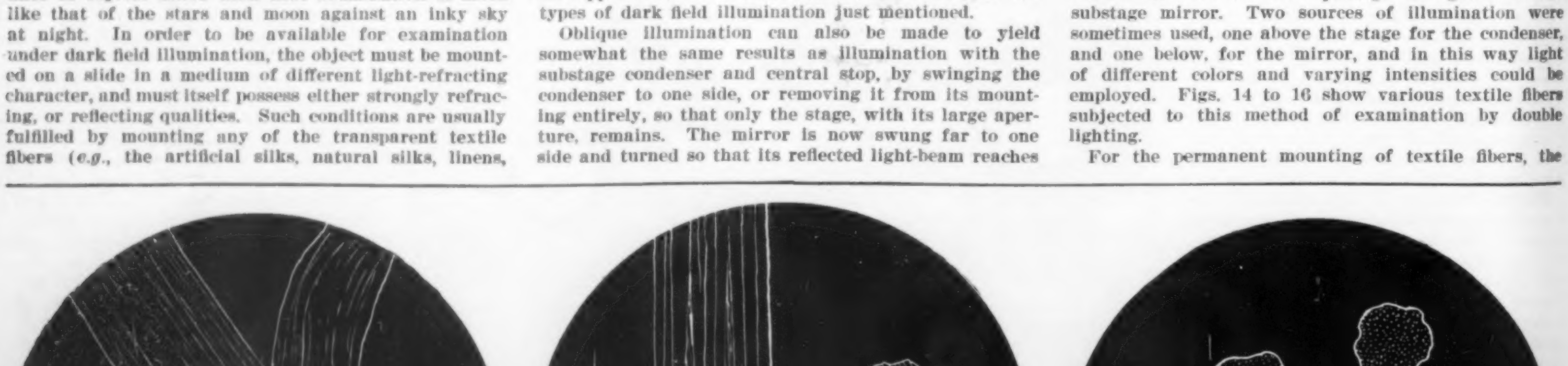
Dark field, or dark ground illumination, seems to be little used or little understood except by microscopists, and yet it is one of the most fertile methods of examination of delicate objects. By dark field illumination is meant that form of illumination by which the object appears light and the background dark. The appearance of objects under dark field illumination is much like that of the stars and moon against an inky sky at night. In order to be available for examination under dark field illumination, the object must be mounted on a slide in a medium of different light-refracting character, and must itself possess either strongly refracting, or reflecting qualities. Such conditions are usually fulfilled by mounting any of the transparent textile fibers (*e.g.*, the artificial silks, natural silks, linens, etc.) in Canada balsam, or some heavy oil, such as oil of cedar, or castor oil. Only such light as is intercepted by the objects under examination, reaches the eye, hence the appearance of a brightly lighted object upon a black field.

Dark field illumination can be had in several ways. The simplest method is to cover the aperture in the stage with a piece of black velvet (since this reflects so little light, even less than carbon paper), and then concentrate, upon the object on the slide, the light from the microscope lamp, using for this purpose a condensing lens mounted on a stand (Fig. 4). With such an arrangement, a very small fraction of the light from the condensing lens is reflected back into the microscope tube, while the object itself appears brightly illuminated. Such treatment works well, however, only with those fibers which are more or less opaque, the transparent, glassy fibers demand a modification of this method. This modification, designed for those fibers, which refract well, but do not reflect the light (such as the transparent artificial silks) consists in mounting them in Canada balsam, and illuminating them with the light from the substage mirror, using the dark-ground stop, furnished with all Abbé condensers. With this type of dark field lighting, the object still appears light upon a dark ground. Figs. 8 to 13 show the appearance of various textile fibers under the two types of dark field illumination just mentioned.

Oblique illumination can also be made to yield somewhat the same results as illumination with the substage condenser and central stop, by swinging the condenser to one side, or removing it from its mounting entirely, so that only the stage, with its large aperture, remains. The mirror is now swung far to one side and turned so that its reflected light-beam reaches the object on the slide very obliquely. If the light is sufficiently oblique, none will enter the objective except that which is intercepted by the object on the slide, which will, therefore, appear light upon a dark background. This method possesses the disadvantage, however, that it can be used only with low powers, *e.g.*, with the 16-millimeter objective, and furthermore that the object itself is illuminated only on that side from which the light proceeds.

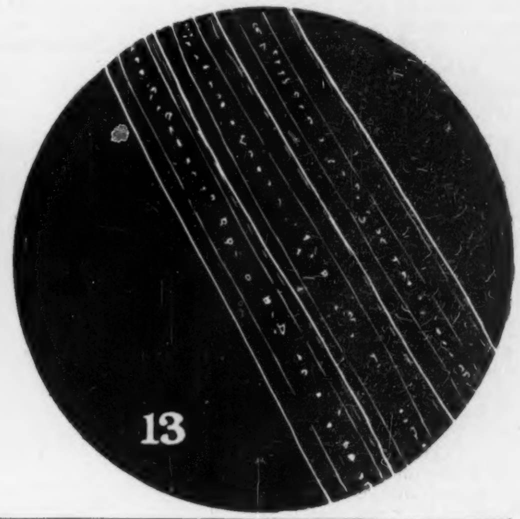
Excellent results have been obtained by a combination of transmitted light (either vertical or oblique), and the first type of dark field illumination, in which the condenser on a stand was employed. With this type of lighting the fibers were mounted in some light oil (or glycerine, as has been recommended), such as oil of amber, oil of bergamot, oil of cayeput, oil of wintergreen, and oil of clove. Xylol and water were often also used as mounting media. The reagent which afforded the most satisfactory results, however, was oil of amber, with which the fibers were thoroughly saturated after having been washed (in the case of the natural fibers) with a solution composed of equal parts of ether and 95 per cent alcohol, or (in the case of the artificial fibers) with hot soapy water, to remove any oily matter from their surfaces. The velvet cloth was not used in this connection, as it would have interfered with the passage of light from the substage mirror. Two sources of illumination were sometimes used, one above the stage for the condenser, and one below, for the mirror, and in this way light of different colors and varying intensities could be employed. Figs. 14 to 16 show various textile fibers subjected to this method of examination by double lighting.

For the permanent mounting of textile fibers, the



8. Tussah, or wild silk. 9. American-made cellulose silk. 10. The same fabric in transsection

Three dark-field views of silk fibers from different sources



11. Jute. 12. Sea-island cotton in cross-section. 13. Flemish flax.

Three more dark-field exhibits

writer has found that Canada balsam and glycerine jelly answer all practical purposes. It is believed to be better, however, to keep textile samples filed away in envelopes, in a classified card-catalog system, and make preparations freshly when needed for comparison. In this way special methods of mounting in different media, for special methods of illumination, can be applied to each individual set of fibers, which would not be possible were they mounted once for all in Canada balsam or glycerine jelly. Each set of fibers should be determined, the determination noted on the envelope, and the envelope filed away where it can be at once available. Each envelope should bear, moreover, an account of the treatment found best to bring out the characteristics of the fiber, on which indubitable determinations can be based.

The enormous saving of time, labor and expense, together with the accuracy of the results of identification which microscopic analysis makes possible, should commend itself to all those who are working in the field of textile identification for the establishment of a system of uniform nomenclature of textile products.

Swimmer's Cramp—Its Causes and How They May Be Avoided

By J. S. Taylor, Captain, Medical Corps, U.S.N.

SWIMMER'S cramp is a spasmodic contraction of a muscle or group of muscles, as in the calves of the legs, the arms or the belly wall. Muscle cramp or tetanic contracture results from what is called summation of stimuli. The repeated and rapid contraction of a muscle induces fatigue and then temporary paralysis. The degree of fatigue necessary to produce spasm would, of course, depend on the tone of the muscle. A weak, undeveloped muscle would become fatigued sooner than a well developed one. An important factor in muscle spasm is the accumulation in the local circulation of waste products incident to exercise known as "fatigue stuffs." These fatigue stuffs undoubtedly act as a chemical irritant to the muscle, increasing its susceptibility to tetanic spasm. Therefore, the activity of the local circulation is of immense importance in this connection.

In Asiatic cholera the enormous reduction of body fluids by diarrhœa increases the viscosity of the blood and produces marked interferences with the capillary circulation. In this disease the patient experiences very distressing cramps in the muscles of the abdomen and of the calves of the legs.

Men who work in the hot firerooms of ships, especially inexperienced firemen, suffer from similar muscular cramps. They work hard, drink a great deal of water, cold as they can get it, perspire profusely and often chill the body surfaces by standing half naked under blowers and ventilators.

With normal exertion of a muscle of good tone and with a normal circulation, tetanic spasm will not occur. The weak muscle or the over-stimulated muscle tends to spasm, and spasm is further favored either by an excess production of fatigue stuffs or by the deficiency of the local circulation on which the removal of these fatigue stuffs depends. In the case of the cramps developing in cholera the circulatory disturbance is the chief one. The muscles are insufficiently nourished, enfeebled, and so predisposed to spasm from the smallest degree of exertion and the capillary deficiency prevents the removal of the chemical products of muscular contraction.

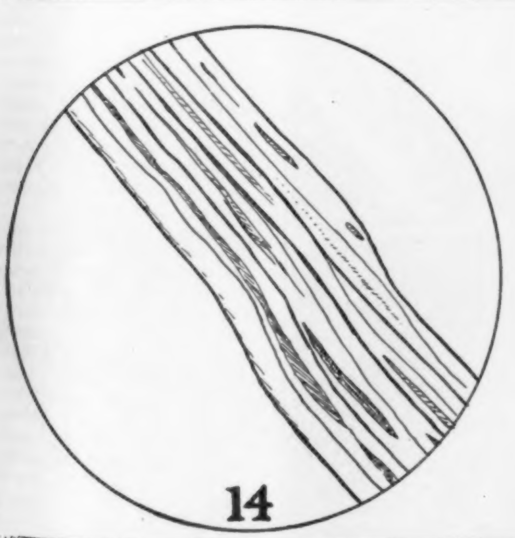
In the case of firemen, the over-use of the muscles and disturbances of circulation act together in producing cramps. The profuse sweating reduces the total bulk of body fluids and the chilling of the body surface, along with the consumption of large quantities of water, tend to cause a congestion of the internal organs with a consequent collateral anemia in the superficial blood vessels.

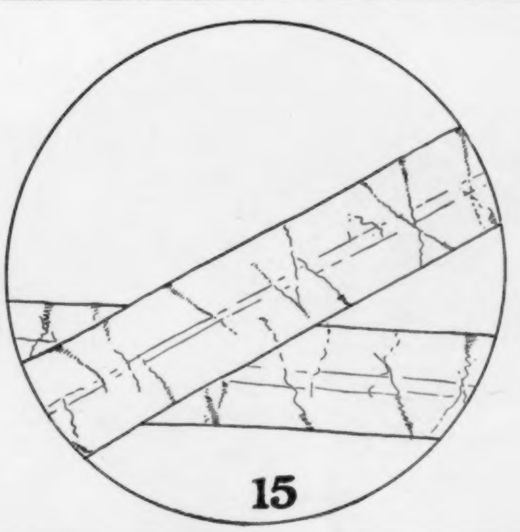
Practical conclusions to be drawn from these facts in relation to swimmer's cramp are simple. Do not stand about at the water's edge too long before entering the water. While it is a mistake to plunge in when the body is greatly overheated, it is just as bad to wait a long time to cool off first. Do not go in swimming after a hearty meal or after consuming large quantities of water. Several hours should intervene between a big meal and swimming.

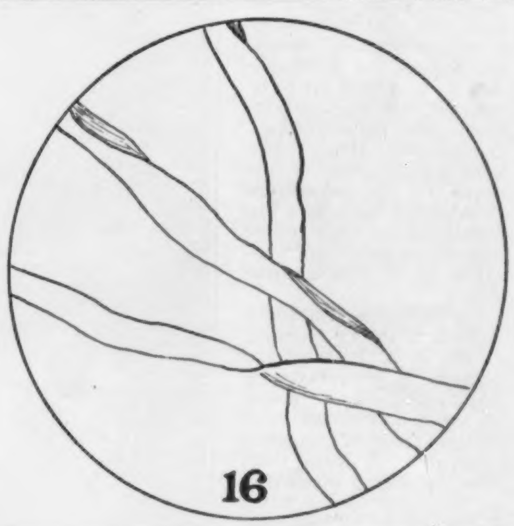
In the next place, when considering swimmer's cramp, it should be remembered that swimming is a very active exercise, calling into play nearly all the voluntary muscles of the body and it is easy to overdo. The amount of exertion which can safely be made in the water without liability to muscle spasm depends in part on muscle tone. The person who takes comparatively little exercise on land, whose muscles are more or less soft and flabby, cannot reasonably expect to make undue calls on his muscles without unpleasant and dangerous consequences when he is exercising in the water.

It is possible that swimming in very cold water may increase the tendency to cramps. Even when exercising only moderately, most people stay in bathing too long, cramps may come from long-continued moderate use of the muscles just as readily as from excessive use of them for a short time.

Considering the large number of deaths that occur annually through swimmer's cramp, more thought and care should be accorded this subject. In many instances it is due to carelessness or lack of knowledge.







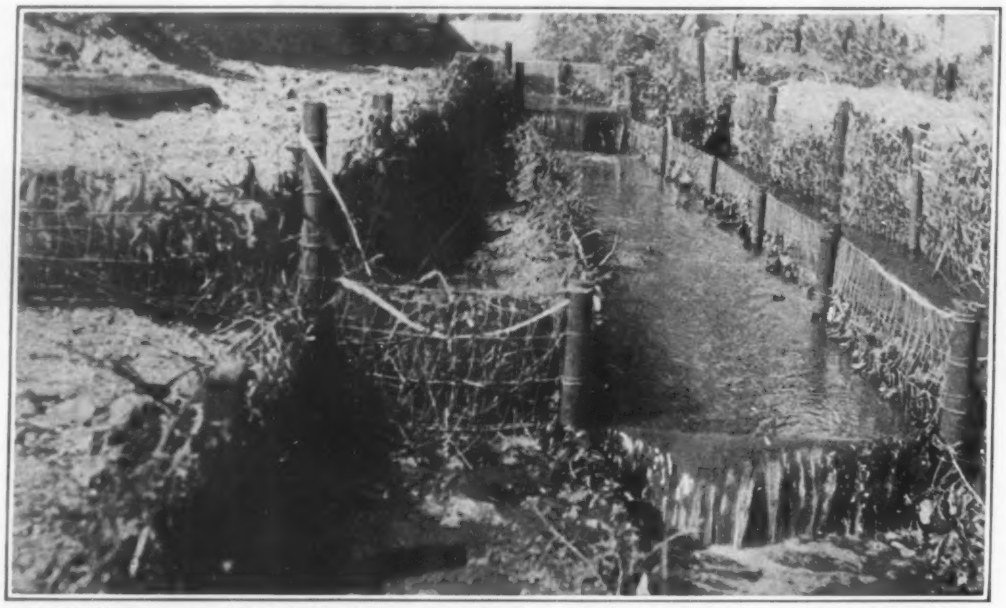
14. Japanese mulberry silk, in oil of amber. 15. Purified French ramie linen, under the same treatment as the last. 16. Unmercerized cotton in oil of bergamot. Note the absence of twist

Three different fibers as seen under Dr. Hausman's double-illumination technique

Making the Flood Dam Itself

A Simple Wire Netting Structure That Gathers Mud, Boulders and Miscellaneous Debris to Form a Barrier

By J. F. Springer



The Pratt porous dam installation after nominal flood. Note dead branches, leaves and other floating debris which have been caught and held by the skeleton-like structure

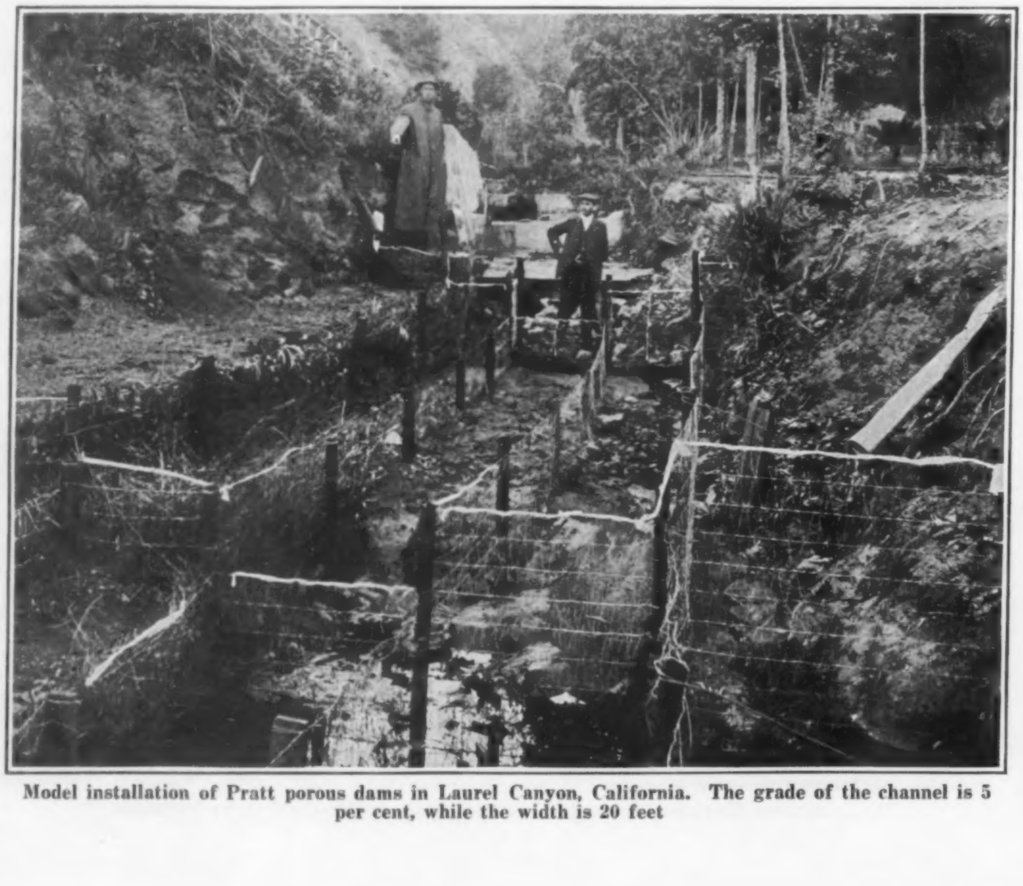
ONE great idea being pressed today in the industrial world is automatic operation. Sometimes it can be fully realized. The raw material is then simply put in at one end and the work taken away at the other with the desired operations completed. Then there is semi-automatic operation, when the full ideal can not be realized. Here there must be human control and attention for part of the operation. The civil engineers have not done a great deal along this line; so that when something of the kind is accomplished, it is all the more worthy of attention. A case in point is a rather novel type of dam that is being developed in California. This dam, once started, builds itself. As the initial construction is highly economic and the remainder is accomplished automatically, the cost of the finished affair is very moderate indeed. However, this type of structure is not usable everywhere, nor is the method universally applicable. But where the finished structure fulfils the demands and where also the conditions make the semi-automatic method applicable, we have a splendid result.

Torrential streams are rather famous for the trouble of which they are capable. They can be cured, and are being cured; but the usual method is rather expensive. The result is that but little is done, unless conditions are such that a profit may be secured by the use of the power water impounded. The upper reaches of the St. Maurice River in Canada have been put under control at great expense. But this expense is justified by the hydroelectric power stations downstream, whose operation is thus extended. Similarly, the Catawba River in the South has been put under limitations as to what it is permitted to do in flood seasons. But, aside from the insurance to property and life, the expenditures for the control works are expected to be warranted by the money return secured through conversion of the energy into electric current. Unfortunately, however, conditions are often unfavorable from the point of view of those who wish their money to earn more money. Investments from the humanitarian point of view are to be expected only from governments and philanthropists. Consequently, the development of a cheap type of dam suited to the purpose of checking the floods of a torrential stream might easily turn out to be a distinct advance in a humanitarian way.

The California dam, which appears to be the invention of Mr. A. A. Pratt of Los Angeles, is started on its way to completion by a simple skeleton-like construction built in part of materials close at hand. Thus, posts from the nearby woods may be set up at special points in the stream bed and these connected up by lengths of wire netting. Other forms of construction are permissible, if they seem preferable for particular cases in hand. The broad idea consists in the erection of a system of obstructions which are sufficiently open to permit the water to flow through rather freely, but which will nevertheless stop and retain floating debris, such as the dead branches of trees and other scrappings of the vegetable world. As these accumulate, the flow of the water becomes more and more impeded. The checking of the flow of running water carrying silt and the like tends to result in the deposition, first of the heavier particles and bits, and, as the retardation becomes more effective, of the finer and less heavy particles. The floating material is stopped and made to pile up and check the water, and this hindrance of flow results in filling in the interstices. Ultimately, what is the equivalent of a solid structure is produced. The water impounded upstream becomes more and more quiescent as the current slows up. Coarse and then fine sediment is deposited in the bottom of the pool. If the stream bed is rocky and bare, this deposition of sediment tends to fill in and cover up. After a time, however, if the flood continues, the top of the network will be reached by the accumulations, and the water will flow over the structure and continue on downstream. The dams are anchored further upstream for the purpose of holding them in place until their weight has sufficiently increased to prevent them being carried onward. It is said that, when once the basins commence filling up, there is no danger of a shifting of the stream bed.

These dams are built in systems. Thus a cross-section of the stream and bed may show on both sides a stepped arrangement from the bottom up. Then, there may be a second stepped arrangement disclosed by a longitudinal section. This latter arrangement suggests the terrace-like form of a natural rapids. There seems to be a rule which requires that the top of a dam shall not rise above the foot of the dam next to it upstream. It is to be understood that the foregoing sets forth only broad features. The space back of the porous dams may be cut up into rectangular compartments. Two sides of each rectangle may be made to parallel the current. The other sides will then be perpendicular to it. This compartment construction may be utilized to control the cross-section of the resulting impervious dam that the stream will build.

The terracing of the sides of the stream bed tends to confine the most rapid current to the center, and the less rapid currents to the two sides, the currents slowing up as the banks are approached.



Model installation of Pratt porous dams in Laurel Canyon, California. The grade of the channel is 5 per cent, while the width is 20 feet

Several years ago, a stretch of porous dams was constructed in the bed of Laurel Creek Canyon, near Los Angeles. Part of the region tributary to the creek having been burned over, the torrential character of the stream was increased. More water came and it brought a great deal of material with it. After the flood, it was found that the one-mile stretch of dams was in good conditions and that about one hundred of the secondary compartments had been filled with material. There was a protected channel about 25 feet wide.

Another porous-dam system was constructed for the Water Conservation Association of Riverside, California. The stream whose waters it was to control is a "contour canal." Next to it is a wide flood water channel. Most of the year the stream bed is dry. It is very rocky, being thickly strewn with small and medium sized boulders. A natural water basin lies below the upper strata in this region. It was desired to check the occasional floods and compel the water, or a large part of it,

to sink down into the water basin, from which it might be recovered and utilized.

A porous dam 130 feet long was built across a narrow place in the channel. At one end a 40-foot wing set at right angles was constructed. There is one main barrier for the full length and two supplemental front barriers. Iron posts 3 inches in diameter or angle irons were planted in the stream bed and given a height above it of perhaps 6½ feet. Wire guys were anchored upstream back of the posts and served to assist the posts in resisting downstream thrusts. These wires were perhaps ¾-inch in diameter and reached back, say, 10 feet. There might be several guys to a post, the conditions naturally ruling in the matter. The anchorages were made to heavy boulders and were apparently sufficiently secure, as they withstood a flood in February, 1920. The upright posts were connected up by means of angle irons, and the frames thus produced were covered with wire mesh. This consisted of a fabric made of ¼-inch wire leaving 6-inch apertures. The fabric was, at the bottom, carried upstream for about 16 feet and the apron so formed weighted with boulders.

The February flood tried out the dam. After it was over, the structure was seen to be undamaged. On February 22, the water was flowing over the top of the upper dam in a stream 4 feet deep. On the following day, the water had dropped 3 feet, but was of course still covering the structure.

It is claimed that the back-cutting action of the overflow from a built-up dam of this description differs from that which occurs in the case of the ordinary solid dam. The inventor says: "After this mattress is completed, the overflow then acts exactly as it would in the case of the solid dam, with the difference that the back-cutting can only proceed to where it encounters the mattress previously built by the stream itself, when the menace ceases. With a solid dam, when the back-cutting reaches this same point, it connects with the water percolating from the reservoir and a channel is apt to be opened under the structure, which automatically enlarges until the solid dam fails."

The stream here resisted has a gradient of nearly 4 per cent. It may be almost or quite non-existent or it may have a depth of 4 to 8 feet and width of 500 feet. Boulders and small pieces of solid matter are carried or rolled along by the swift current. Bed rock is everywhere out of sight near the location of the dam, covered up doubtless by the material brought to the spot and deposited in the years gone by.

The foregoing account refers to a system patented by Mr. Pratt June 4, 1918. A basic idea of the scheme contemplates the establishment of a central series of dams located along the longitudinal line of greatest depression in the bed of the stream. These dams will be of short or moderate cross-section and do not seek to dam the entire stream. In fact, each may be only a fraction of the cross-section of the stream in flood. The one located farthest downstream is set at any point considered favorable. The next upstream from it will have its bottom on a level with the top of the first or perhaps a trifle lower. The successive dams of the central series, as one goes upstream, will have their bottoms at the level or a little below the top of the next dam downstream in the series. This central series serves to locate and define the course of the stream at all times whether it is in flood or not. To each side of it, another longitudinal series is also arranged. The foremost dam in each series will be abreast of the leading dam of the control course, but set at a level such that its bottom will be at substantially the same height as the top of the dam in the central series. The next dams upstream in these side series will be similarly located with respect to the next dam upstream of the central line. And so on up the river. Other side series are similarly set up, the bottom of any dam in a transverse series being at substantially the same level as the top of the adjacent dam on the side of the center of the stream. The ends of dams are now connected with the ends of others downstream that are at the same level. Compartments will thus be formed of rectangular plan. The wire-mesh walls toward the center and downstream are at the level of the tops of the mattresses formed in the adjacent compartments. When the mattresses are all complete, the whole affair will be a series of steps whether one views it crosswise or longitudinally. The stream will flow between two flight of steps.

The steps tend to become permanent elements in the stream bed because of the sand and other hard and imperishable material arrested by the mattresses of vegetable débris that form. If there should be a poor natural supply of such débris, the deposition of sand and the like might have to be assisted either by using a closer mesh or by providing vegetable waste. What is essential is that the water be checked in its flow, as this is the manner of getting deposits to form. Of course, if there is quite a flow of small boulders, these may become an equivalent of vegetable débris. They will be halted by the wire mesh and build up a loose, open pile. This in turn will check the impetus of the water and bring about the deposition of sand and the like.

After the flood. Receding waters have eroded the deposited sands in accordance with the layout of the structure. In fact, the channel is automatically self-cleaning

Some Simple Pointers on How to Keep a Car

By Harold Hollingshead

SOME people wonder why they are sick when they don't take a bath but once in two weeks, and some people wonder why their car won't run when they don't clean it but once a month, and then never touch the inside of the motor. What we need is not greater motors, but drivers who will study the construction of a car and treat it as though it were human.

The very first thing is a familiar warning—keep the inside of a motor free from carbon; but everybody does not know how to do it. To start with, have the valves properly ground and adjusted and all carbon burnt out. After this is well done, a teacupful of kerosene put through the pet-cocks twice a week will keep the motor in good shape. After the kerosene is equally distributed through the various cylinders, the motor should be given about ten turns, either by hand or by using starter. This will soak the entire motor with kerosene. Then apply the switch, giving the motor a medium amount of gas. In cold weather this remedy should be applied after the motor is warmed up, or in returning to the garage in the evening, otherwise the motor will require some skill to start. After the motor is started and gets warmed up, running at a medium speed, open one pet-cock at a time, while motor is in operation, and you can notice the fine pieces of carbon coming out. This kerosene can also be applied by using a small oil can, applying the kerosene through the air adjustment of the carbureter while the motor is warm and running at a medium speed, as the motor dies down. While kerosene is being applied, keep hand on the throttle of carbureter and increase speed.

Another point is removing the plugs once a week and soaking them in a pail of kerosene overnight, then using a little emery on the points, drying them well; also adjusting all the points accurately to the thickness of a dime. Then see that none of the porcelains is broken, which will cause a missing cylinder. Also see that all the porcelains are thoroughly tightened by small nuts that are at the top of porcelains. After this is done, each plug should have a washer and be thoroughly tightened in the cylinder head.

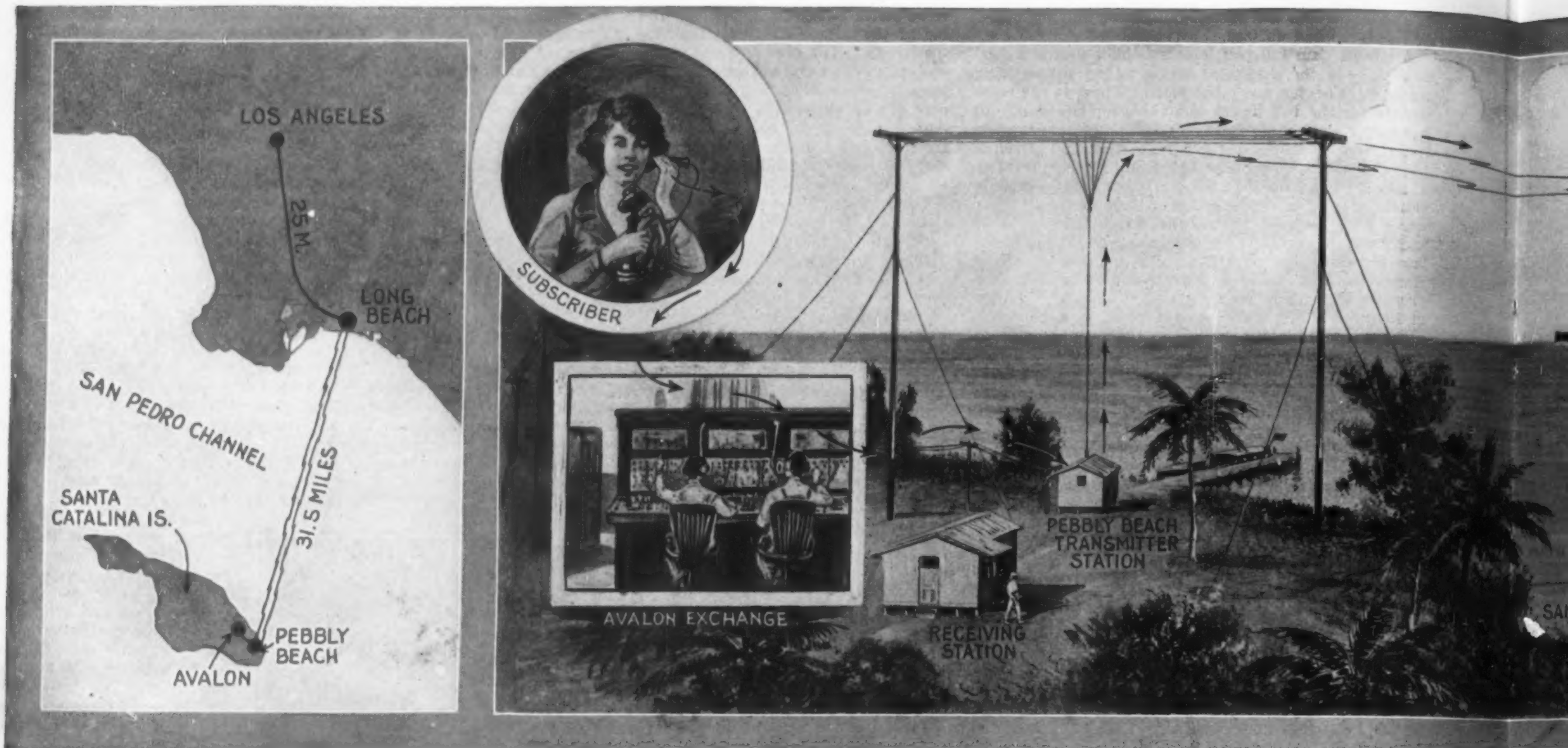
Most people have trouble with their motor heating up, and it is no wonder when the water that is in the radiator has collected so much rust and grit that it has shut off the circulation through the various cylinders. This grit is removed by running the front of the car over a manhole or drain, while the motor is in operation. You will find a small outlet plug at the bottom of the radiator on all makes of cars. After opening this, take off the cap from the radiator water intake and apply a hose with running water. Let the motor run until the water from the outlet pipe becomes clear. You can easily notice the collected rust and grit as it comes from the outlet pipe. This operation once in two weeks, together with keeping the cooling fan well oiled and in perfect running condition, will give you a perfect cooling system.

Oil should be drained from the crank case once in three months and new oil applied. The same should be done in the transmission and differential cases, and these cases should at all times have the proper amount of a good quality of oil and grease. An occasional application of neatsfoot oil to the clutch will keep it in good condition, together with keeping the grease cup well filled.

The brakes should be properly adjusted. After jacking the rear of the car up, with the motor running in low gear, one man should operate the foot brakes back and forth, while another applies kerosene to the brake bands. This will remove all grease and grit and give perfect action on the brakes. If the brake linings are badly worn, and you want to come down a steep hill without relining brakes, apply hose of running water for about five minutes, soaking each brake lining in water. This will expand your brakes and give you quick action for a short time. Keep all parts of machinery oiled, and tires properly inflated to the proper number of pounds. One drop of oil applied to the valve of the inner tube before air is applied will prevent any air from escaping from tire.

A rag partially dampened in kerosene and oil is an excellent remedy to remove all sand and grit from the body. To keep from scratching the paint on the body, great care should be taken to shake out the cloth thoroughly as you go along, as this cloth will accumulate much grit, which is very injurious to paint. After this is done, a clean piece of silk cloth from an old shirtwaist will wonderfully brighten up the paint.

In driving a car do not advance spark on starting, or on a hill or heavy pull, or your motor will start knocking. Restart your spark and you may not get the speed, but you will eliminate the knock and make your motor last twice as long and save your repair bill. In running your motor idle, slow down to lowest possible speed. This will keep the motor from heating up and eliminate the collection of carbon in the motor and will also save the gas bill. In starting and stopping at all times shift to low or intermediate gears, which will save you the strain which would come on the motor by pulling in high gear.



General arrangement of the radio link which connects the telephone system of Santa Catalina Island with the California mainland, together with a

The Radio Li

Extending the Usual Telephone Service by Bric Telephone Installatic

THERE is genuine romance in the story of the radio telephone. A dozen years ago it was a crude laboratory toy, with little prospect of ever becoming a practical, workaday thing. It was handicapped with a most unsavory reputation, because it had been made the catspaw of fraudulent stock-selling enterprises. The very publicity which had been accorded in unstinted measure had done untold harm, for the general public had come to expect too much of this young and quite unwieldy means of communication.

The radio telephone started out as a competitor of the wire telephone, although in truth it could never hope to rival the more conventional system. Yet the radio telephone only started on its practical career when the telephone engineers—the very men against whom this newer form of communication was to compete—took an interest in certain radio equipment, particularly vacuum tubes, and developed them to a practical point. Today, the radio telephone is not a competitor of the wire telephone: it is an accessory. It became practical through the efforts of the telephone engineers, but in turn it has made wire telephony possible over longer distances and with greater clearness than could ever have been possible with the former equipment.

The radio telephone today is part and parcel of our wire telephone system, and it is fast becoming as practical as the latter. Indeed, were it not for the high cost of this form of communication, it would be quite within present accomplishments for any telephone subscriber to call up a relative or friend on an ocean liner several hundred miles off shore, the voice being carried over the usual telephone line to the central office, through trunk lines to the distant radio transmitter, and thence transmitted through the air to the steamer. The radio link, as the radio telephone service is called when made a part of the usual wire telephone system, is destined to become commonplace within the next few years.

Now the foregoing is not a mere flight of fancy. It is a matter of record that the American Telephone & Telegraph Company recently conducted a series of experiments with radio links and the transcontinental telephone line. Telephonic communication was established between the steamship "Gloucester," cruising off Deal Beach, N. J., and Santa Catalina Island, situated some thirty miles off the California coast in the vicinity of Long Beach. The telephonic communication, in this case, passed from the "Gloucester" to Deal Beach, N. J.; from Deal Beach to New York via telephone line; from New York to San Francisco via transcontinental telephone line; from San Francisco to Los Angeles via telephone line; from Los Angeles to Long Beach via telephone line; and from Long Beach by radio to Pebbly Beach, on Santa Catalina Island. From ocean to ocean via radio, telephone line and radio again!

The first commercial radio and connecting land toll line is the Santa Catalina Island and California radio link, which was set in operation well over a year ago. Radio telephone service between Santa Catalina and the mainland to connect up with the Bell System exchanges was installed at the request of the local telephone company. Catalina Island is one of the great tourist resorts in California. It attracts thousands of visitors daily throughout the year, who, heretofore, when they left the California mainland, remained completely isolated from the rest of the world until they returned to Los Angeles, except for a much-overloaded naval radio telegraph station on the island.

That this radio link, which bridges the 31½-mile gap between the island and the mainland, is not in the experimental stage may be gathered from the fact that it handles hundreds of messages each day. The large amount of commercial traffic with scarcely any interruption which the Avalon–Los Angeles toll circuit has carried every day since its opening, is an ample proof of the practicability of toll lines containing radio links, where, due to physical conditions, direct wire connections are impracticable.

It is virtually impossible to delve deeply into the intricacies of the Avalon–Los Angeles radio link and toll circuit, since it involves the most elaborate telephone and radio engineering practice. Suffice it to say that the diagram at the right of the above panel shows schematically the Avalon–Los Angeles circuit, consisting of a little more than one mile of wire line from the Avalon central office to Pebbly Beach, a 31¼-mile radio link to Long Beach, and 25 miles additional wire circuit to Los Angeles. This combination wire and radio circuit is operated as a unit providing through telephone and signaling from Avalon to Los Angeles. At Avalon the circuit may be connected with any subscriber's line and at Los Angeles to any local subscriber's line, through local exchanges, or with other long-distance lines reaching practically any subscriber in the Bell System.

The difficulties overcome to surmount interference from radio stations along the Pacific Coast and a naval station on Catalina Island, together with the many sets on ships, were many, we learn from the engineers of the American Telephone & Telegraph Company and the Western Electric Company, who installed the radio link. Practically uninterrupted service now has been made possible, however, and the quality of the transmitted speech is almost perfect; so much so, in fact, that a user of the telephone service that includes the radio link notices virtually no difference in the service.

Among some of the technical obstacles it was found necessary to overcome before satisfactory operation of the radio link was possible was the problem of housing the receiver and transmitting apparatus in the same building or in close proximity. This was accomplished by properly shielding all leads, shielding the receiver to prevent cross-talk from the transmitter, and the use of specially designed filter circuits for the receiver.

The radio link is, in truth, a link. It functions as part of the regular telephone system with little or no extra complication, so far as the everyday operation and use of the system is concerned. Operators are located at the central offices in Los Angeles and Avalon, operating ordinary telephone switchboards. They handle the radio link traffic in the same manner as if the wire circuits were being handled. They ring up in the same way by the operation of the usual ringing key. In fact, the installation of a voice frequency ringing system, which permits the use of a ringing key at the regular exchange switchboards in Los Angeles and Avalon, for signaling gave rise to some trouble and necessitated some changes in design before it was successfully placed in operation. This was due to the fact that the apparatus was rushed for the installation before it had been given a thorough field trial by the engineering department of the Western Electric Company.

The radio link is a duplex system; that is to say, one message may be sent in each direction simultaneously. For transmitting, a fair-sized aerial is employed, as indicated in the accompanying bird's-eye view, while for receiving a loop antenna is used at each end. These loops are of the solenoidal type, six feet square, and consist of only four or five turns each. To make the duplex operation a success, it goes almost without saying that exceptional measures had to be taken, otherwise the transmitter at one end would drown out the incoming signals on the loop antenna but a short distance away. The elimination of such interference was attained by the use of different carrier frequencies for transmission in the two directions. Filters, amplifiers and repeaters are employed in large numbers, the basis of all this equipment being the improved vacuum tube. An interesting feature of the receiving apparatus is the provision of relays which close a buzzer alarm circuit when the filament of any vacuum tube fails.

The radio transmitter employed at either end makes use of a circuit in which the oscillations are generated directly in the antenna circuit. The modulation of the radio carrier frequency is accomplished by what is known as the "constant current system," in which both oscillator and modulator tubes are of 50 watts rating. These tubes are of the coated filament type, having relatively low filament power consumption and very constant operating charac-

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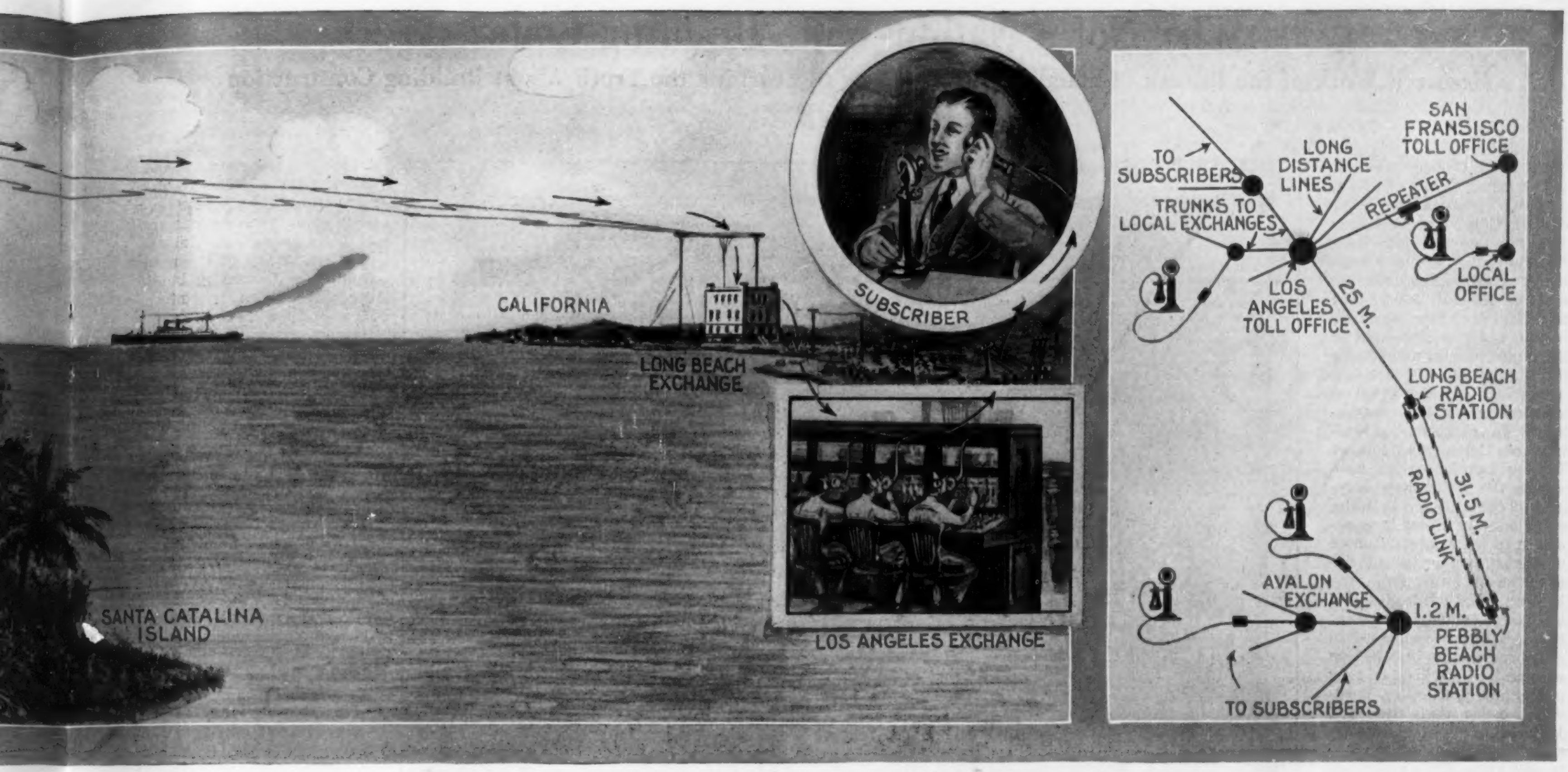


...and, together with a map of the territory served by the radio link and a schematic presentation of the radio link's role in the telephone system

...Radio Link

...Service by Bridging Present Gaps with Radio ...phone Installations

...teristics. The transferring of the speech current from the telephone line to the radio link is an elaborate process. Briefly, it may be described in this manner: The speech current is applied to a speech amplifier tube, through an input transformer. The output of this amplifier is impressed on the grid circuits of the two parallel modulator tubes through a transformer. The action of these modulator tubes is that of an amplifier and their output voltage is impressed on the plate circuits of the two oscillator tubes by means of a reactance, which is common to the modulator and oscillator plate circuits. This modulation of the oscillator plate potential results in speech frequency variation of the amplitude of the antenna current. The frequency of the antenna current when not modulated is nearly that corresponding to the free period of the antenna circuit.

Since the radio link is the only telephone channel between the island and the mainland, it was very heavily overloaded from the day of opening until the cessation of the summer tourist traffic in the latter part of September, 1920. Due to the methods employed, the high grade circuit, and so on, a great deal more traffic is handled over this circuit than is generally handled by a single toll line.

A record of all of the interruptions to service is kept at both of the stations together with the cause of the delay, its duration, and other information. It is interesting to note that although the circuit was open to commercial service during the worst of the static season, subscribers had but little or no difficulty in using the circuit. Transmitting frequencies of 400 and 470 meters were chosen for the stations after an extensive survey of the ether, so that the telephone would cause the least interference to and be interfered with the least by radio stations in the vicinity. Some trouble was experienced from the Avalon spark station located about one mile from the receiving station at Pebbly Beach. This station employed a transmitting frequency of 300 meters, while the Pebbly Beach station had its receiving apparatus tuned to receive 470 meters. Upon investigation it proved that the wave emitted by the spark transmitter was a broad one, and that when the wave is kept sharp and within certain definite limits of purity, so to speak, little or no trouble is experienced from this station.

The circuit, due to the choice of sites, directional characteristics of the loop antennas, and selectivity of the radio receivers, is quite free from interference and it is only occasionally that an interfering spark signal is heard. The harmonics from the Poulsen arcs installed at the Naval Radio Stations at San Diego and Englewood, California, have given rise to some trouble. If the arc harmonic beats with the radio carrier and side frequencies of the radio telephone station at either an audible or nearly audible rate, the quality of the speech over the circuit may be affected materially. This is in effect the same result which obtains when speech signals are received on an ordinary heterodyne receiver when the local oscillator is not adjusted to the same frequency as that of the transmitter. Although this trouble can be eliminated as soon as it is discovered by shifting the carrier frequency of the radio telephone transmitter a few thousand cycles, it is obvious that in the future, when many stations may be expected to be operating, this difficulty must be eliminated in a more elaborate manner.

The radio link also provides for a full duplex radio telegraph circuit, capable of sending and receiving messages in two directions at the same time. Ordinary telegraph instruments are used at the terminals and ordinary telegraph lines lead to the radio installation. This duplex telegraph service operates simultaneously with the radio telephone with no interference whatsoever.

Electrostatic Adhesion Phenomenon and Its Application to Radio

AN interesting phenomenon of adhesion arising from electrostatic attraction was described before the Institution of Electrical Engineers by Mr. Alfred Johnsen and Mr. Knud Rahbek, of Copenhagen, who noticed in 1917 that strong adhesive forces were developed in some cases when an electric potential difference was applied between a solid body consisting of certain badly conducting materials—*e.g.*, various minerals—and a conducting body, such as a metal disc, resting on the former body.

The adhesion was found to be due to a strong electrostatic attraction between the two surfaces in contact, and to be proportional to the true area of contact between the bodies, so that ground and polished surfaces fitting accurately together afford the best results. The solid materials in question conduct electrolytically and show a very high contact-resistance with regard to an adjacent conductor, if no conducting liquid or cement be interposed between the two surfaces. The contact-resistance can greatly exceed the normal resistance of the material used. If a potential difference be applied between the metal disc and a metal electrode cemented to the semi-conductor (as the material may be called) a weak current will flow through this semi-conductor and across the contact surface to the metal disc. This gives rise to an appreciable potential difference between the surfaces in contact, owing to the very high contact-resistance, and the result is an unusually strong electrostatic attraction. The attraction between the plates of an "air condenser" for a given potential difference between the plates is proportional to the inverse square of the distance between the plates, and in the present case, the distance between the attracting surfaces being theoretically zero, an infinitely large attraction should be expected. In practice a smaller attraction is observed, the reduction being probably due both to electrolytic phenomena and to ionization; nevertheless, an exceedingly strong attraction can be obtained at moderate potentials.

It has been found that an electrostatic attraction of several pounds can be obtained between a thick lithographic stone, fitted with an electrode at the back, and a metal disc 2 in. in diameter resting thereon, when a potential of 440 volts is applied. The current is of the value of a few micro-amperes. The disc will lift the stone in a manner exactly similar to that in which an electro-magnet can be lifted by its armature, and the stone will drop if the current be interrupted. Similar qualities are exhibited by flint, agate, some species of slate, and many other minerals and salts, as well as by many organic substances—for instance, animal membranes, skin, gelatine, bone, etc. On the other hand, the experiment cannot be carried out with true insulators such as glass, mica, hard rubber, etc., as the necessary current cannot flow.

The considerable friction caused between the two surfaces by the attraction may be utilized for technical purposes by using the semi-conductor in the form of a cylinder, which is kept in rotation and on which slides a metal band. As soon as a suitable potential is applied to the apparatus, the band will adhere firmly to the cylinder and can be made to operate various devices, the whole forming an effective electrostatic relay. In connection with telegraph apparatus it is essentially useful as a radio recorder, the current from ordinary small valves being sufficient for its operation at a speed up to several hundred words per minute, if a sufficiently high potential (100 to 200 volts) be used for the valves. If the metal band be connected to a diaphragm or similar sound-reproducer, and telephone currents be applied, a very loud-speaking telephone is obtained. A low-tension pocket electroscope forms another application.

Research Institute in France

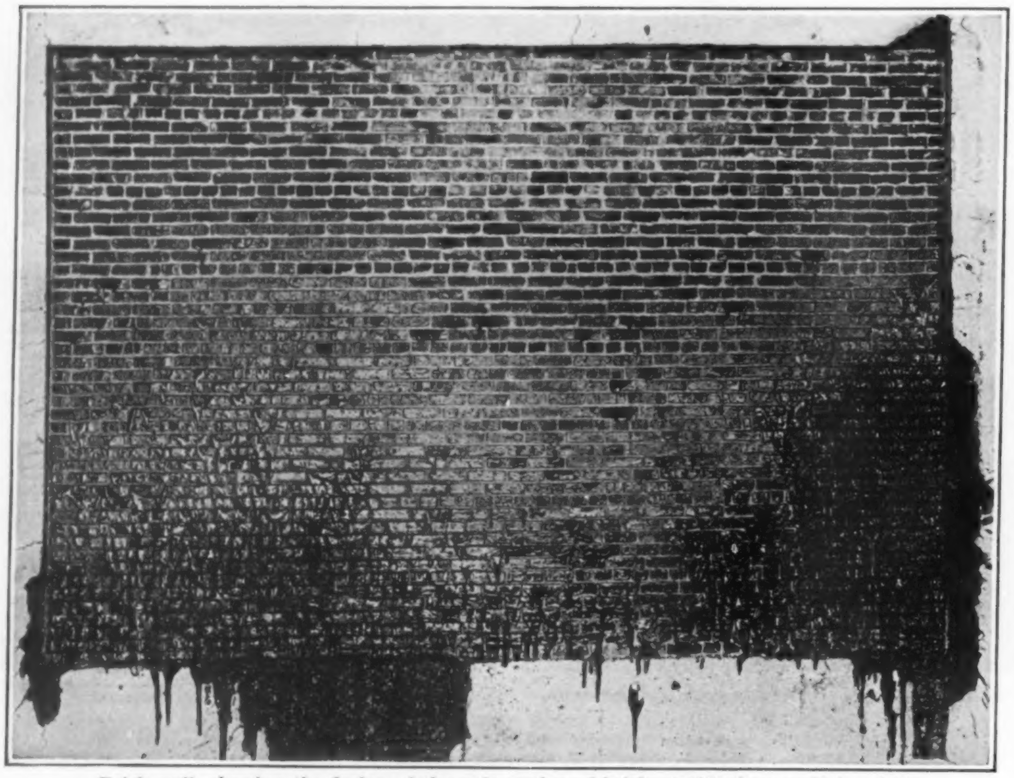
BARON EDMUND DE ROTHSCHILDS, administrator of the Eastern Railway of France, has given ten million francs to found a scientific institute, the object of which is to encourage students to take up research as a career. Particular attention is to be given to researches looking to the application of science to industry and agriculture. The institution is to be managed by a council, two members of which are elected by the Academy of Science and the French Museum.

Why Not a Nation-Wide Building Code?

Research Work of the Bureau of Standards with a View to Learning the Truth About Building Construction

By Geo. H. Dacy

RECENT house famines, housing congestion, building inadequacies and construction inefficiencies have rung up a reverse English bull's-eye to the extent that Government officials and authorized Federal agencies are now devoting serious study and thought to the matter of systematizing our haphazard, catch-as-catch-can methods, modes and measures of construction. In particular, Secretary of Commerce Herbert Hoover has interested himself in the satisfactory solution of our national building enigma. His efforts have resulted in the organization of a special committee of national authorities from the leading building trades and associated industries who, at this writing, are engaged in the formation and perfection of standardized building codes, plumbing codes, hardware codes and the like. In this work of uniformly standardizing the various building trades activities, the national Bureau of Standards is cooperating and doing the majority of the testing and theoretical—as well as much of the interpretative and fundamental—research and investigations on building methods.



Brick wall, showing the fusion of the soft grades of brick at 2150 degrees Fahrenheit

Right now the Standards experts are comparing the requirements in building codes of some 300 cities in order—as far as is possible and practical—to standardize and unify these construction commandments and to formulate reasonable rules and regulations which will be the basis for potential and safe construction. There are approximately 450 cities in the country at present whose populations range from 10,000 to 25,000, that are not governed so far as building activities are concerned by standardized requirements. At least 65 per cent of these cities have no building codes whatsoever, while the minor municipalities which boast any codes at all in some cases offer a sort of crazy-quilt-like, heterogeneous assortment of unrelated codes which dovetail together in about the same way that a square is related to a circle. Out of more than 300 American cities with populations in excess of 25,000 one-quarter have no building codes while the construction requirements enforced by many of the cities which have codes are variable without any apparent cause. The common plan followed in cities without orthodox building codes has been to use the State building codes, the fire underwriters' codes, or the decisions and judgments of special committees of municipal authorities.

The steel frame used at the Bureau of Standards for the retention of the brick panels subjected to the fire resistance tests

The Federal Government has no power in the matter of these building regulations otherwise than in an advisory capacity, as this work rests entirely with the different states and municipalities. The proposed standardization of construction requirements would be of outstanding assistance to the smaller cities which cannot afford the heavy expense of formulating definite local building regulations. Furthermore, such standardization would undoubtedly result in a marked curtailment in building costs and equipment installation expenses in many cases. The Bureau of Standards in reducing the matter of building code systematization to a workaday basis is conducting many worthwhile, unique and original tests and investigations. The results emanating from these experimental investigations are of basic importance in emphasizing many of the most significant factors in building codes which, heretofore, have either been ignored through ignorance or have been neglected through carelessness.

Practical, fundamental and essential tests are being made to ascertain the fire resistance of various types of wall construction. In one of the Government testing laboratories, large rolling steel frames have been constructed and are placed in succession directly above a series of powerful oil burners. Brick wall panels of different types 16 feet long, 11 feet high and 8 to 12 inches or more in thickness are built in or close to this steel frame forming one side of the furnace chamber and, subsequently, exposed to flame action at high temperatures for long periods to determine their reactions to continued fire exposure. Generally, these test panels are fired continuously for about 6 hours or until they fail, or show excessive deterioration and injury. The heat generated by the oil burners is such that at the end of 1 hour, the temperature of the furnace is raised to 1700 degrees Fahrenheit, while it rises to 2000 degrees Fahr. at the termination of 4 hours and attains the peak point of 2150 degrees Fahr. at the end of 6 hours. At this latter temperature, the less resistant varieties of brick melt on the inner face and pour down over the impaired panel as shown in the illustration above.

The Government scientists and engineers in charge of these experiments measure the bulging and inclination of the panel walls towards the flames in order to determine under what conditions the fire is liable to cause the collapse of the brick walls. Various electrical indicating devices are used to measure the temperatures at different portions of the walls during the tests, more than 1000 such temperature readings being taken in the case of each wall panel that is fired. To date, the tests have included the tryouts of both solid and hollow brick walls of 8-inch and 12-inch thicknesses. The steel frame in which the brick panel is built and the panel itself when ready for test weigh about 25 tons and constitute the most ingenious method ever devised for exposing brick walls to fire hazards for experimental purposes.

In the solid wall panels 8 inches thick, 2200 bricks are used, while in the construction of the 12-inch test panels 3300 bricks are required. Where hollow brick walls are used, approximately 25 per cent less brick is used while the labor expenses in building the wall

are slightly lower than for solid brick, so it is reported.

In general, the purpose of the laboratory fire tests with these brick walls is to determine the stability of the different walls; if they will buckle decidedly where exposed to extremes of heat and flame; and whether or not they will conduct heat to the extent that articles and goods stored on the opposite side of the wall will also be fired or damaged by the abnormal development of heat. The experimental panels are tested under two different conditions: (1) With the walls under full restraint and built solidly in the steel panel, duplicating conditions that obtain in the lower floors of a tall building, and (2) with open spaces left around the top and sides of the walls to allow them to expand. This latter arrangement approximates the conditions which occur in light buildings and on the top floors of many buildings.

During the last 18 months, the Bureau of Standards has been assisting the National Lime Association, the National Association of Plasterers and the American Plasterers' Union to compile a standard plastering code of countrywide application. This work is now about half completed and promises potentially to modify radically existent deficiencies in plastering operations. Usually the average home owner becomes more familiar with the plastering and plumbing in his house than any other duo of the construction features. Uncle Sam's construction authorities and other national agencies are trying to standardize in black and white the facts and figures which will provide the householder with accurate information which will tell him whether or not his special job of plastering is good—and if it is bad, why it is unsatisfactory. The Bureau of Standards has been conducting new and original tests and research activities with lime and gypsum to ascertain inside knowledge about these materials, which, previously, has been unknown. Plasters are made entirely of lime and gypsum which ordinarily have to be used together. In most localities this means that one or the other of these materials has to be imported at considerable trouble and extra expense. Lime is used because of its plasticity, while gypsum is essential on account of its quick setting characteristics. Heretofore, the individual properties of these two materials gave no evidences of interchangeability. However, the Government experts have already devised a system which gives plasticity to gypsum and a quick set to lime. These invaluable experiments will result in the future use of one or the other of these materials according to available local resources, but will not require the use of both materials to insure durable and satisfactory plaster surfaces. This means a big annual saving to contractors, builders and private individuals, and is the sort of worthwhile investigation which merits our hearty commendation.

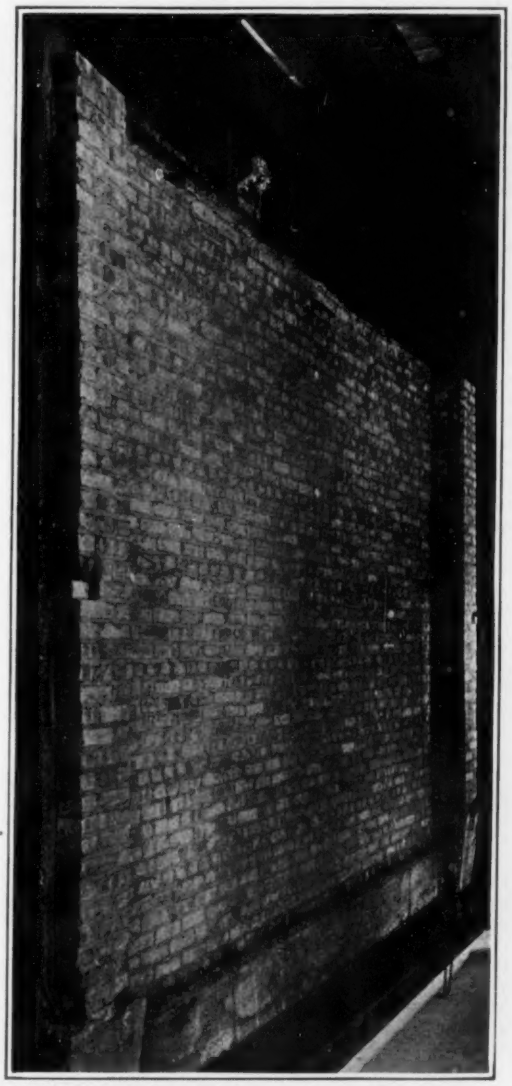
The Bureau of Standards has also evolved a method of coloring plaster so that attractive and ornamental wall finishes result, which eliminate the necessity for using decorative wall paper.

Little is known about plastering sands by either the laity or building experts. The Government scientists are now conducting a detailed investigation of plastering sands in order to substitute definite facts and figures for our existent ignorance concerning the best types of this building material. They are also devoting particular attention to the perfection of a method of making gypsum weatherproof so that it may be used as a finishing material on the exterior of buildings. Their efforts have been effective in a reduction of 50 per cent in the time devoted to the curing of sand-lime bricks and this has meant a great saving in production costs to the manufacturers of this material.

At present, a special new laboratory is being equipped at the Bureau of Standards for investigating the effect of fire on different structural building materials. These tests show that timber weakens about 50 per cent in total strength when exposed to a fire temperature of 100 degrees Centigrade. At exposures of 100 to 150 degrees C., the timbers begin to give off light volatile materials, while at temperatures of 200 degrees C. they become soft and spongy.

Structural grades of steel begin to lose strength when the heat register hovers between the 350 and 400 degree Centigrade mark, while at exposures of from 550 to 600 degrees C. steel fails under average working loads. If the temperature is increased to 800 degrees C. the very finest steel possesses only a small fraction of its original strength. The novel apparatus consists of a restraining frame of structural steel, a special loading mechanism and electric furnaces for supplying heat and maintaining the temperature uniform throughout the test specimen. Special temperature recording devices equipped with microscopic facilities for the efficient detection and interpretation of minutely sensitive fluctuations are used in this work. The importance of these fire tests is strikingly indicated when one stops to consider that destructive conflagrations annually cause property losses which aggregate over $300,000,000, an amount equivalent to one-fourth the total operating expenses of the United States Government, and which exceeds the annual appropriations of the United States Army and Navy.

An electric ice machine capable of making one ton of ice daily is being used by the Federal engineers to chill an experimental chamber wherein all kinds of building materials are exposed to weathering conditions—laboratory duplications of the deteriorations and damages which obtain from the alternate freezes and thaws and the disruptive operations of Jack Frost. In a single day's exposure in the cold chamber, a sample of building material such as sandstone, marble, granite, concrete or the like is subjected to the same number of climatic vicissitudes as it would undergo in one year's weathering. The rock samples are first soaked in water



Solid brick wall tested free in the panel. The top of this wall bulged out 6 inches from the top of the pilaster, but sprang back after cooling

and then placed in the novel ice box and subjected to severe and extended freezing. Some of the samples are frozen and thawed 50 to 60 times which is representative of the deterioration they suffer under natural conditions in as many years.

Tests have been made of sandstone similar to that used in the construction of the White House and the National Capitol building. When exposed to alternate freezing and thawing equal to 55 years of weathering, this material broke down and showed marked signs of crumbling. At the time when these Government buildings were erected, this particular variety of Virginia sandstone was popular and largely used for building purposes. The only reason why the executive mansion and the official headquarters for our national lawmakers have lasted so long is because both buildings are protected efficiently and well against weathering injury by regular applications of waterproof paint, which prevents the moisture from penetrating into the stone.

Complete tests of every conceivable mixture and combination of concrete are also under headway as an important phase of the national housebuilding problem. The unique flow table designed and perfected at the Bureau of Standards some time ago for determining the consistency of concrete, is being used to good advantage in these studies. Waterproofing and oil proofing tests of concrete cylinders are being conducted, records being kept of the penetration of cottonseed oils, fuel oils and gasoline into various mixtures of concrete. Novel compression or crushing tests to ascertain the durability of marble, slate, granite and other rock material for building uses are also in progress.

The properties of hollow building tile are being closely studied, this investigation having been in operation for about 12 months. Fire tests are being run of various kinds of tile emanating from different sections of the country.

Extensive experiments have also been carried on to determine the most efficient and satisfactory methods of soundproofing the walls, ceilings and floors of apartment and office buildings. The early investigations have been so successful that work will soon be begun on the construction of a new, large and complete acoustics and sound laboratory where more varied and extensive tests will be run in the future.

The proper, durable and efficient utilization of paint as a preservative and protector of wood has been studied in detail and results of interest and value to the average laymen have been obtained. One common cause of the failure of paint is due to its application in unseasonable weather or due to the fact that it is applied on wet surfaces. The wood surface to be painted should be wholly dry and the weather should be dry and clear when the paint is applied. In order for complete and proper adherence to the wood, the paint must be evenly coated over a moisture-free wooden surface. In itself, the thin layer of paint which is between .001 and .003 inches in thickness, affords but little protection and adds practically no strength to the surface where it is applied unless this work is consummated under the most desirable conditions. Light is one of the most destructive agencies which causes paint to deteriorate rapidly. This explains why the dark-colored paints are more durable and weatherworthy than the lighter hues and colors, as the former materials are more opaque and cut off the light more efficiently to the extent that the light has less chance to penetrate to the oil which is the part of the paint which is most susceptible to early injury and decay. One of the greatest economies in house and building decoration would obtain if the public could be educated against the use of white paint for exterior use. Just to show the damaging effect of light on paint, observe the north and south sides of a house that has been painted for some time. Invariably, the paint will fail on the south side of the house before it begins to deteriorate seriously on the northern exposure, due to the larger amount of sunshine and light which concentrate their attack on the south side of the building.

Uncle Sam's specialists are also conducting the most thorough series of experiments relating to the corrosion which occurs in building materials, that have ever been attempted. Metal sheets of various materials used largely in construction work have been exposed to weathering conditions for periods of five years at three different stations in the country, which differ materially in climate.

The Bureau of Standards has also carried on complete tests of all varieties of stucco. During recent years more than 300 different panels of stucco have been constructed and tested out under actual building exposure conditions. The panels—each of which was 15 feet long and 10 feet high—have been plastered with different combinations of cement, lime and gypsum, the common plastering materials. These panels were erected as part of the exterior walls of a storage building at the Bureau and have been under constant study and scrutiny since their completion. Important facts such as the following resulted from these tests: (1) Cracks which have occurred have not been due to settlement but to an improper method of sheathing, (2) Where hair was omitted from the first coat of plaster the lath is more completely imbedded, (3) The lighter shades of stucco show cracks less prominently after wetting than the darker shades, (4) The best method of finishing stuccos is to produce a rough surface such as the "rough-cast" or "pebble-dash" finishes, (5) Stuccos may be satisfactorily applied on monolithic, concrete bases and (6) No fundamental cracks have been identified over joints in tile, brick, concrete block or gypsum block.

The Bureau of Standards has also run a thorough test of more than 180 structural steel columns used in construction work.

Lightening the Draftsman's Load

Labor Saving Devices That Go Beyond the Familiar Square, Triangle and Rule

By E. S. Van Brunt

THERE are on the market numerous ingenious devices designed to save time and labor for the draftsman. Thus, a novel device for inking dot-and-dash lines consists of a triangle, T-square or straight edge (Figs. 1 and 2) with an intermittent groove cut in it just back of the edge, together with a small metal attachment which can be adjusted to the nib of any ordinary ruling pen. This attachment when adjusted to the ruling pen travels along the intermittent groove, the uncut portion of which causes the pen to be lifted off the paper registering the spaces between the dots and dashes, while the cut portions form the dots and dashes. Triangles and straight edges may be cut with grooves to give any combination of dot and dash lines desired; and best of all, the grooves do not in any way affect the edges for straight line work.

A very convenient form of protractor combined with an ordinary triangle is shown in Fig. 3. This device saves having two separate instruments to handle, and answers the purpose of a more expensive protractor for most of the ordinary work in drafting, the protractor being graduated to angles of 1 degree.

Figs. 4 and 5 are "lettering angles" designed to give a quick and easy method of drawing accurately spaced guide lines for lettering drawings.

There are six columns of holes, the columns being subdivided into groups of three holes, while the holes of each group are joined by scored lines. The figure under each column denotes the height of the standard capital letters in thirty-seconds of an inch. The purpose of three holes in each group is to enable the drawing of three guide lines for each line of lettering, when it is desired to use both lower case and capital letters. The "lettering angle" is designed to slide on the hypotenuse when making standard spacings, but either of the other two sides may be used to get other spacings.

To use the lettering angle the pencil point is placed through a hole in the desired group and the angle slid along the edge of the T-square, of the ruler or of another triangle; the pencil point is then placed through another hole and angle slid back. The lettering angle is moved along very easily by the pencil. The holes are tapered to prevent the breaking off of the pencil point. The guide lines are very accurately spaced and drawn much more rapidly than by laying off with scale and dividers.

The angles scored across the lettering angle enable one to obtain angles of 15, 45, 60, 75, and 90 degrees from either a 45 or 60 degree triangle, by setting these scored lines on horizontal or perpendicular lines of the drawing. The lines drawn at right angles and parallel to the hypotenuse are particularly valuable when sketching or doing work without the use of the T-square, because it facilitates very much the drawing of one line at right angles to another. The lines on the lettering angle throw no shadows, whereas the edge of the angle does.

In Figures 6, 7 and 8 are shown several forms of section liners. These instruments are very convenient and useful where a large amount of cross hatching is to be done, especially if uniform spacing of the cross section lines is desired, as in plate work for reproduction. They are provided with adjustments which give a very good range of spacings for the lines.

The instrument shown in Fig. 9 is a special form of triangle in which are combined angles for drawing lines of 15, 30, 45, 60, 75 and 90 degrees, an irregular curve, a protractor with graduations of 1 degree, holes for drawing guide lines for lettering and a scale graduated to sixteenths of an inch. For sketching, this is a very useful instrument as it saves having a number of different instruments lying around in the way.

The universal drafting machine which is shown in Fig. 10 is, as its name implies, in quite universal use in large drafting rooms. It is one of the greatest labor saving devices for draftsmen on the market. It combines in one machine the T-square, the triangles, the scale and the protractor. It is attached to the drawing board by means of an anchor piece fastened by screws rigidly to the board, the machine proper then being attached to the anchor piece. The parallel motion obtained by the double arm always keeps the scales at the same angle with the edge of the board in moving them from place to place on the drawing. The edges of the scales are used as straight edges for drawing lines. The protractor scale is on the head, to which the scale carrier is pivoted. This carrier is clamped to the head by means of a spring. By raising the spring with the thumb the carrier is easily rotated to set the scales at any desired angle. The whole operation is easily and quickly performed by the left hand, leaving the right free for drawing. It is estimated that in machine drawing 25 per cent of time is saved by the use of this tool, and in civil engineering work 50 per cent.

Another device making use of a parallel motion is the pantograph shown in Fig. 11. This instrument is used either for reducing or enlarging drawings, and is invaluable for this purpose. It consists of four bars joined together in the manner shown. The instrument is pivoted at one corner to a weight or fixed standard. At another corner a tracing point (A) is provided, which is moved over the outline of the drawing to be reproduced. The motion of this tracing point is transmitted to the pencil point at B by means of the parallel motion, causing it to describe exactly the same outline as followed by the tracing point A. By changing the length of the bars and shifting the pencil point any desired proportions (within the limits of the machine) may be obtained.

For drawing ellipses, the instrument shown in Fig. 12 is very useful and convenient. It consists of a triangular frame mounted on three legs, in the lower end of which may be placed needle points to hold the frame from slipping when in operation. On the rods A and B of the frame are mounted two carriers, C and D. C is so mounted that it is free to slide on rod A and D is free to slide on rod B. In a bearing on carrier D is mounted a vertical shaft E, the upper and lower ends of which form clamps for carrying the graduated beams F and G. At one end of F is mounted a pen or pencil point P, while at one end of G is a pin K that is pivoted in carrier C and to which the operating piece O is attached. The handle H is for holding the instrument when in use.

To draw an ellipse the beam F is adjusted in the clamp and secured with a set screw, so that the distance from the pencil point to the center of E is equal to one-half the length of the minor axis of the ellipse. In a like manner the beam G is adjusted so that the distance from the center of pivot pin K to the pencil point is equal to one-half the length of the major axis. By giving the operating bar one complete turn a perfect ellipse mathematically correct is obtained. With the ellipsograph shown in the figure ellipses up to 5x9 inches in size may be drawn. Circles may also be drawn with the above instrument, by placing the center of pin K directly over center of piece E.

The beams F and G are graduated to facilitate the setting of the lengths.

Another great labor-saver is a device for stamping titles, lettering or designs on tracing cloth. It is useful only where the same lettering or detail is repeated on a number of different sheets—as titles or standard details that repeat often. It consists of first making an impression with an ordinary rubber stamp, inked from an ink pad as usual, and while the impression is still moist applying to it a small amount of a specially prepared black powder. The surplus powder is then brushed off, leaving the impression jet black and clear. So as to remove any of the black powder sticking to the tracing other than on the design, the impression is washed with gasoline, and then a second, but this time a white powder is sprinkled on the design and rubbed for a moment with the fingers, when the design, lettering or standard details will be jet black, gasoline-proof, smear-proof and ready for use, blue-printing perfectly. This process requires but a few moments and gives perfect results.

Steel Direct from the Ore

PRESENT day practice in the steel industry of practically the whole world is to smelt iron ore in a large blast furnace, thus converting it into pig iron. The next step is to transform this pig iron into steel by remelting the pig iron or taking it hot as it comes from the blast furnace and transforming it into steel by any one of the standard processes. This practice of employing the blast furnace means really the reduction of the iron ore to iron with which there is mixed three to four per cent of carbon. The conversion of this iron into steel means the removal of most of this carbon again, for steel is iron with but a small quantity of carbon in it. Present world-wide practice then is reduction of iron ore to metallic iron, putting in a large amount of carbon and then taking it out again.

From this it is readily recognized that if some process could be devised which would eliminate the necessity of the carbon, the whole steel-making method would be revolutionized. This has been the dream of many scientific men for many years. Translated into plain language this means a method of making steel direct from the ore instead of what most regard as the indirect process now used.

The public and technical press has been quite alive recently with various articles on this subject in which new processes and patents have been aired extensively. They originate in foreign countries as well as in the United States. The principle of all of them is the treatment of iron ore, usually in a finely divided condition, with coal or coke, also finely divided, in a special furnace heated with some reducing gas or other fuel so that the iron ore is reduced or separated from its oxygen and the iron converted into a metallic form known as "iron sponge." This is relatively pure iron except for the original impurities in the ore and it contains practically no carbon. Its conversion therefore into steel direct would be a comparatively simple matter except for the fact that the iron in the form of iron sponge is easily reoxidized by the air when hot and, as it is always hot in such a process, this circumstance has interfered with its conversion into steel. Recent patented processes claim to have overcome this prominent drawback.

It is not possible in a short article of this nature to enumerate in detail the various processes that have been proposed. The most important ones by names are the Jones process, the Bourcord, the Lang (American), the Basset (French), and the Moffat (Canadian). A brief analysis of each of these was published in the SCIENTIFIC AMERICAN MONTHLY for July, and more detailed descriptions have appeared in *Iron and Steel of Canada* and the *Canadian Mining Journal*. They all aim at the same object and differ in apparatus for reducing the ore and handling the iron sponge. Some claim to have been successful in preventing the oxidation of the sponge and in producing steel economically. Most of them use electric furnaces to complete the melting and refining of the iron sponge into steel.

The great drawback to any direct-from-the-ore process for steel is the cost as a competitor with the blast furnace or present methods. It is claimed that the former can never compete with the latter. In some localities, such as Canada or California, it may be possible to use one of the new processes, but not where the blast furnace is now used. Some day such a process will probably be perfected but it will probably be many years. It is not safe to condemn it offhand for stranger revolutions in metallurgy and in other industries have been wrought, and the unexpected or even unexplained of yesterday is but the commonplace of today and tomorrow.

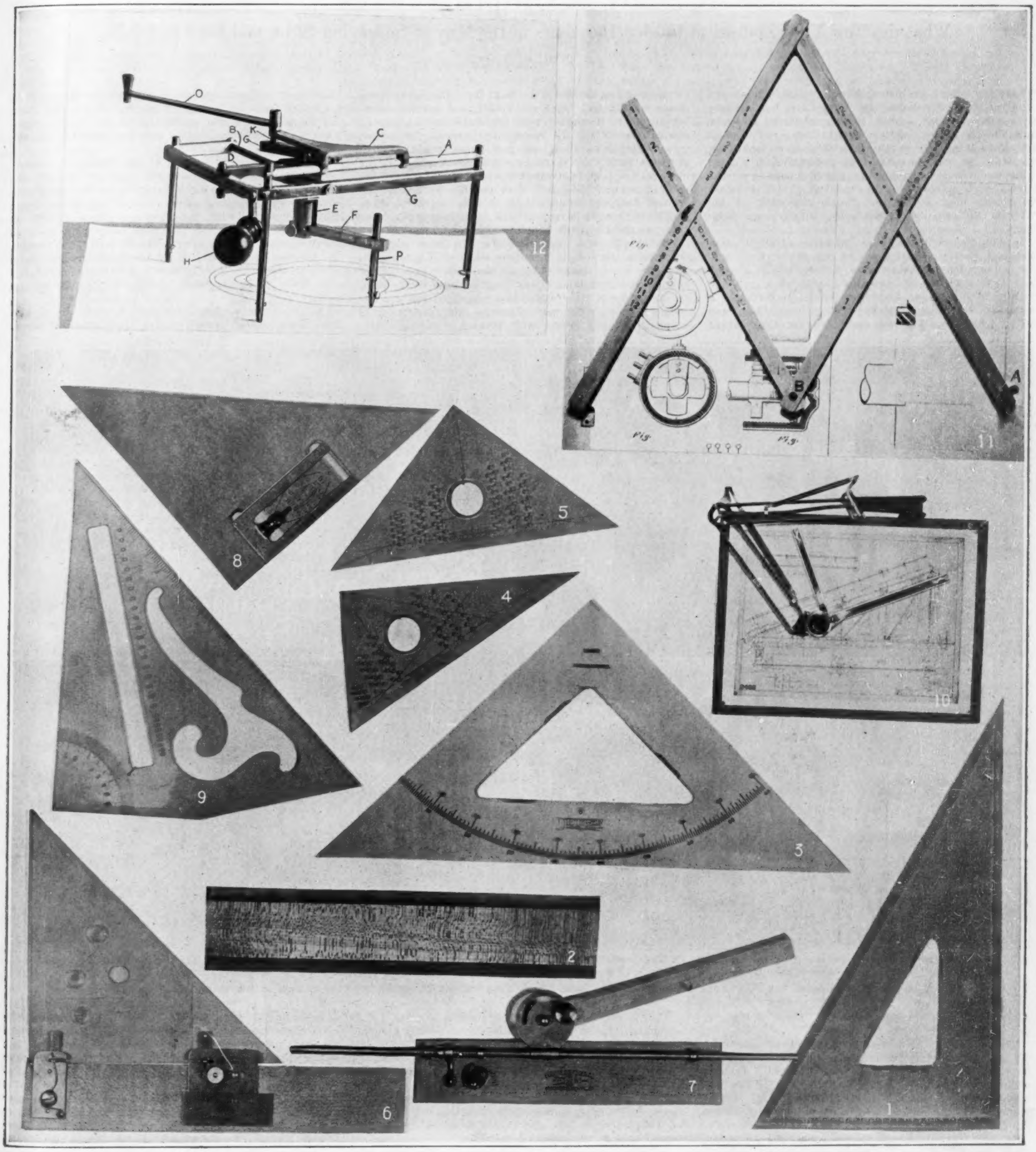
A Gravity Spray System for Orchard

IN the Wenatchee fruit district of Washington where many of the orchards are on land with a considerable slope, a new system of spraying is coming into use. The previously adopted method, which is still, of course, the prevalent one, is a portable power sprayer which moves about the orchard, the pumped liquid spray being applied through a hose. The new method dispenses with the portable equipment, and substitutes a "system."

Thus at Sunnyslope in Wanatchee, on the Moss ranch, a 1000-gallon tank for holding the mixed spraying material has been established at the upper end of the orchard, which is on a marked slope. From this tank a system of underground pipes runs. There is a pipeline to every four rows of trees. Two hundred feet apart on the pipelines are taps.

In spraying, a hose 100 feet long, attached successively at the various taps, enables the worker easily to cover the whole orchard. The fall from the storage tank gives sufficient force. In another local instance, where the fall in the orchard is not sufficient of itself properly to distribute the solution, a small pump is installed at the tank.

Where gravity is the sole force for distributing the spray, this system saves engine and fuel expense. It is found a marked labor-saver, and is of special importance in these days when the average well-cared-for Wenatchee orchard has six to eight sprays a season.



1. Triangle with alternate notches and ridges along the edge, so that a pen with a metal extension piece that runs over the surface of the triangle will draw a dotted or dashed line. 2. Rule with similar arrangement. 3. Protractor combined with the ordinary triangle. 4, 5. Lettering angles; a pencil held in one of the holes will draw a guide-line for lettering when the triangle is slid along on its base. 6, 7, 8. Section liners for producing cross-hatching of more regular character than can be drawn ordinarily. 9. Triangle with all angles that are multiples of 15 degrees, and in addition a universal curve, a protractor, guide line holes and a scale. 10. The universal drafting machine, a single apparatus that does the work of all the familiar tools. 11. The pantograph for automatic copying on enlarged or reduced scale. 12. The ellipse machine.

Some of the ingenious devices that are now available for lightening the draftsman's load

A Study in Offspring Herds

What the New York Zoological Garden Has Done in the Way of Supplying Bison and Deer to Others

By Dr. William T. Hornaday

THE New York Zoological Park, located in the beautiful Bronx Park of New York City, has already an enviable record as the mother of herds of wild animals elsewhere. After twenty years of varied activities, it is well worth while to indulge in a look backward to see what has been accomplished.

By a strange combination of circumstances, the Park's first achievement has proved to be its most important one. It resulted in the founding of the Wichita National Bison Herd, in southwestern Oklahoma.

In 1905, the creation by national action of the Wichita National Forest offered a golden opportunity to establish a bison herd in that region. The New York Zoological Society approached the U. S. Department of Agriculture with an offer to present to the Government a carefully selected herd of fifteen pure-blood bison, and deliver them to Oklahoma, provided the Government would furnish a satisfactory range, fence it securely and maintain the herd.

The offer was immediately accepted by Secretary Wilson; the Society selected the range and proposed its boundaries, and the range was established in close conformity to those plans. In fact, everything was made quite satisfactory to the Society. Mr. Frank Rush, a Colorado cattleman, was selected as warden for the new bison range, and custodian of the herd.

In 1907, when all was in readiness the Zoological Park authorities selected fifteen of the best bison in their herd of about thirty-five head, choosing good breeders and young animals fit to become successors of the adult members of the new herd. There were seven males and eight females, of various ages. By H. Raymond Mitchell, chief clerk of the Park, and Frank Rush, the bison were personally conducted to Cache, Oklahoma, and finally landed in safety and good condition in the corrals of the new range.

Previous to shipment, outbreaks of Texas fever in Oklahoma emphasized the fact that the new bison range was in the Texas fever belt, and solemn warnings came to the director of the Park that the dread disease would kill the bison. In Lawton, Oklahoma, bets were offered that not one bison would survive the first year. As in many other cases, the director of the Park had to assume the responsibility and the risk of action. He felt that the U. S. Bureau of Animal Industry could safely be relied upon to show Mr. Rush how to save the herd from the Texas fever tick; so the risk was taken.

During the first year that the gift herd spent in Oklahoma, two of its members died of Texas fever, and one young animal was accidentally killed. After that, the commendable diligence of Warden Rush, aided by advice from the Washington Bureau, soon got the situation completely under control and permamently stamped out the Texas fever menace.

The Wichita National Bison Ranch, selected by J. Alden Loring, acting as the Zoological Society's agent, proved absolutely ideal for its purpose. The bison herd has thriven marvelously. Without any additions from without, it had increased to a total on January 1, 1920, of 116 head.

Concerning the quality of this herd, we are content to cite only the testimony of Mr. Charles Goodnight, one of the pioneer buffalo and catalo breeders of America, whose herd at Goodnight, in northern Texas, is famous throughout America. After a visit to Mr. Rush and his Wichita herd, Mr. Goodnight wrote to Mr. Edmund Seymour, president of the American Bison Society, that "the Wichita national herd is the finest captive herd that I ever saw."

That herd now is being drawn upon by the Government for animals to go elsewhere to help establish other herds.

Naturally, the withdrawal of those fifteen choice animals from the Zoological Park herd was a severe blow to it. Those animals would not have been sold for other purposes at any price; but it was felt that the founding of a new national herd, at an ideal spot, for the perpetuation of the species, justified the supreme sacrifice that was made.

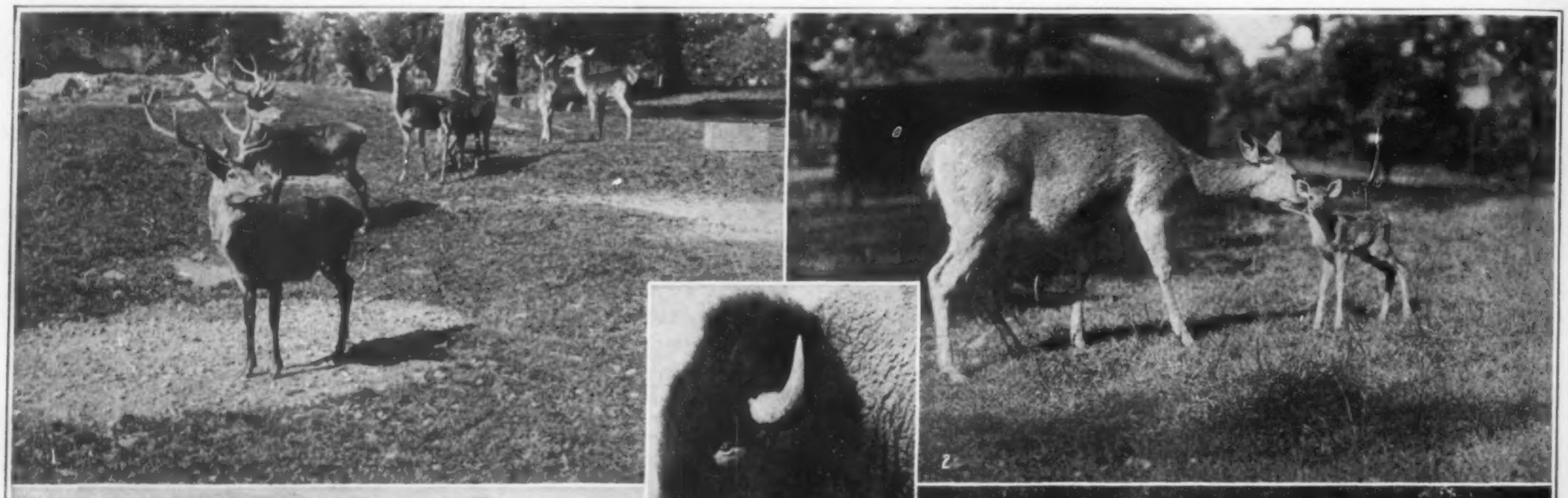
In 1913, the great success of the Oklahoma experiment led the Zoological Society to repeat it for the creation of another national herd. In Wind Cave Park, southwestern South Dakota, the Government cheerfully coöperated with the American Bison Society in a new bison enterprise. This was undertaken through the initiative and the efforts of the late Dr. Franklin W. Hooper, then president of the Bison Society, who pledged that the Society would furnish at least ten gift bison if the national Government would do the rest.

This time the Society furnished fourteen head, and the Bison Society provided for their transportation. The more rigorous climate of South Dakota kept the gift bison busy for a full year in getting settled down in their new home and well started in breeding; but after that the course of the herd ran smoothly. Now the herd contains over 43 head, of quality very satisfactory for the founding of a new bison unit.

Dr. T. S. Palmer of the U. S. Biological Survey now calls the Zoological Park bison herd "the mother herd."

And there is a third herd to the credit of the New York Zoological Society. It is in Denmark, at the Copenhagen Zoological Garden. It sprang from a pair of breeding bison bought from us by Mr. Nelson Robinson and presented to the Danish zoo. Our last information reported six head.

Several noteworthy herds of deer have arisen from beginnings drawn from our parent stock. The first one was due to enterprise of the late Dr. Ray V. Pierce, who, during the last years of his busy life, owned and lived upon St. Vincent Island, just off Apalachicola, northwestern Florida. Of all the places



1. The European red deer herd in the New York Zoological Park. 2. The female Barasingha deer and fawn in the park. 3. "Black Dog," the herd leader of the Wichita national bison herd. 4. Part of the Wichita national bison herd on its Oklahoma range. 5. Crating the original Wichita bison herd in the Zoological Park

Some of the deer and bison of the New York Zoological Park, from which have sprung offspring herds elsewhere in the United States and in Europe

that we ever have seen in the South, St. Vincent Island is the most beautiful, most interesting and most perfectly adapted to the requirements of an ideal game preserve and private hunting-ground. It is highly diversified, both in its forestry, its vegetation and its land and water. If any king ever had a hunting ground like that, he was luckier than most kings of my acquaintance.

To hunt and kill a desirable wild animal on St. Vincent is a man's job, as I can testify. When Dr. Pierce proposed that we should go out and kill a wild bull for beef, I assented languidly, in the belief that it would be a cinch. Now I say, let him who thinks so try it once—that's all! We wounded a lusty bull, and we chased him through the jungle for five straight hours. When the bull finally dived into an impossible swamp, our tongues were hanging out, and we were proud and happy to give up beaten. We were five miles from the hacienda, and so dead tired that when the doctor sent a wireless S O S message by Sam, we filed no objections, but cheerfully waited for a trap to come and haul us in.

The bull was found dead, a week later.

The island contained white-tailed deer; and Dr. Pierce wished to have a larger species. We suggested Indian Sambar deer as a promising experiment. Any and all of the deer of the Sambar group should do well in the South, and produce much good venison. Dr. Pierce bought a trio from us, a fine buck and two does, and in every way did the right thing by them.

But the buck went wrong, for some reason never known, and died in the first year, leaving no children. The next year another buck was sent down. Some offspring resulted, but the increase was not what we had a right to expect. The Sambar now on the island are very wild and shy, and no one can say how many there are; but Dr. N. Mott Pierce writes that the number has increased rapidly and the deer are now plentiful.

It is the fine size of the Indian and Malay Sambar deer that render them desirable for colonization in the South as food producers without artificial food. Of course there are thousands of localities so barren that they could not exist without being fed, but there are also others wherein Nature supplies all their wants.

In quite the opposite direction our herd of European red deer founded an offshoot herd that now is a going concern and a complete success. When Mr. John B. Burnham, the famous president of the American Game Protective and Propagating Association, decided to establish in the North woods of Essex County a fenced deer preserve of 750 acres, and our advice was asked, we recommended as best for his purposes the red deer of Europe. It is smaller than the elk and not one-quarter so troublesome; it is hardy and prolific, and the bucks are not the dangerous brutes that many white-tailed bucks are in the breeding season.

Our suggestion was adopted, and Mr. Burnham drew his nucleus stock from our herd. From the very first moment his experiment has prospered and proven satisfactory. The beginning was made in 1912 with four animals. Since that time many fauns have been born, and the herd has thriven; but for certain good reasons, Mr. Burnham is not satisfied with the red deer as an animal for a small preserve. He writes me as follows regarding his herd:

"The red deer stand the extreme cold of northern New York where the thermometer sometimes drops to 40 deg. below zero without apparent inconvenience. We are in a country of light snowfall, but in exceptional winters have occasionally got from three to four feet of snow. Under these conditions the red deer never yard, and as they are good providers they will live even under conditions where a white-tailed deer would starve. I do not, however, like them as a park animal because they are gross feeders and break down a great deal of small growth which dies and is wasted as a source of food supply. They also eat the bark from several kinds of trees and are, therefore, very different in their feeding habits from our native deer, which are dainty browsers. Where their range is limited the destruction of food is an important asset on the wrong side of the ledger. Therefore, I am getting rid of the deer and at the present time have only four or five of these animals in my park."

In order to visit a herd of barasingha deer (of India) that we recently founded, it will be necessary to cross a bit of blue water. A French gentleman living in the island of Martinique desired a herd of deer suitable for that island and climate. We recommended the barasingha species, and the suggestion was adopted. We sent forward a breeding trio, and in the first year the nucleus herd doubled itself. The owner was delighted; but I have secret fears that ere long he will awaken to the fact that he has more deer than he can well manage, and will be bothered by the surplus.

The barasingha is a beautiful deer of middle size—next below the red deer. It is a good breeder, but nervous and flighty in temperament and difficult to ship without accident. Its summer coat is a bright old-gold yellow.

The bison, deer, tapir, aoudad and other hoofed animals that we have sent to other zoological gardens and parks we do not count, for we do not think of them as being on a herd basis all of our own making. As for the inbreeding bugaboo, that is another story. For healthy wild animals living naturally in great open ranges, there is (in our firm belief) absolutely no evil to fear from inbreeding. This belief is the result of twenty years of close observation of the big game of the world, and the accumulation of many facts.

Linotype Slugs and Catalogues

Printing a University Library Catalogue from Linotype Title-a-Line Slugs

By Howard S. Leach

Reference Librarian, Princeton University

FOR the first time in the history of libraries a catalogue of a large university library is being printed from linotype title-a-line slugs. This catalogue is the outgrowth of a Seminary Finding List, started over 20 years ago. It has been a natural growth, fostered by wholesome demands from university professors for an ever larger scope of usefulness. At first the Finding List contained only such titles as were congregated from the main stacks and reading room in seminary rooms for special advanced study purposes. A demand from the Mathematics Department for a printed catalogue of all mathematic books owned by the library, without regard to location, removed their Finding List from the category of a simple seminary list to a complete catalogue of the books pertaining to a university department. A slug was made for each book on mathematics in the library and a catalogue printed. In like manner, lists were printed for philosophy, Germanic languages, music, European war, etc., etc. The printing of these larger catalogues for departments lead naturally to a cumulated Author Finding List, embracing all seminaries and most of the outlying departmental libraries, and a copy of this was placed at each point of use. The cumulated list contained 628 pages. Demands came for fuller lists from time to time until the work reached a point where not a great many books remained in the general library for which there were no slugs.

The printing of a title-a-line catalogue for the entire library was begun in September, 1919. Slugs were made for such books as still remained without them, and the printing went forward.

The first half of this catalogue will be in classed or classification order, which, like the shelf list or official catalogue, brings all regularly classified titles on a given subject together, regardless of their location in the building. In other words, it is an orderly series of broad subject bibliographies, the importance of which, for reference purposes, is very obvious.

When the classed list is completed the slugs will be rearranged and printed in alphabetical order to form an author catalogue. The completed catalogue will comprise about ten volumes, five of authors and five of classed order. The special collections not classed in the regular manner will be added in a separate volume.

On account of the enormous expense there can be but one card catalogue, while a copy of this printed catalogue may be located at any point in the library or other buildings on the Campus and consulted at will. Its advantages, aside from its duplication and portability, are many. A page contains on an average sixty-eight titles, which may be consulted rapidly and almost at a glance, while to turn over 68 cards in a card catalogue takes very much more time and causes greater eye strain. Each slug forms a title unit. The ability to use these title units in various arrangements by the simple process of sorting makes it possible to provide working bibliographies and special finding lists as aids to study and research. The slugs are pulled out of the main reservoir and when the printing is finished filed back again to await further use, either as a part of the large catalogue or in other special ways. Having the title limited to one bar of 100 letter spaces makes the title units all alike in size and minimizes the danger of misprints and losses of portions of the entry, which is bound to happen if a title is allowed to run over into more than one bar.

A title-a-line linotype slug is a solid strip of metal containing spaces for 100 letters. Within these 100 letter spaces the cataloguer places the name of the author with his initials, a short title for the book, the place and date of imprint and the library call number. Here is a sample slug (shown in two lines instead of one because of our narrow columns):

Strange, T. A. Guide to Collectors. Eng.
furniture, decoration. Lond. (1918?).....4595.884

It will be noted from this sample that 14 of the 100 spaces are not needed for actual letters and are, therefore, filled in with dots that the call number may appear in each bar at the extreme right, thus bringing the call numbers on the various bars in alignment where they are most easily read.

The slug for the regular catalogue is 5½-point type on an 8-point slug, which automatically gives the proper spacing between lines. For subject headings, a 10-point type on a 10-point slug is used, and for straight printing, such as a preface or an introduction, a 10-point type on a 12-point slug. Black-face type, where emphasis is desired, may be used, and both black-face and light-face type may be used on the same slug. Subject headings are made conspicuous by using black-face type. To facilitate handling and alphabetizing, each slug is slipped into a small paper jacket, at the top of which is printed the title it contains.

When not in actual use for printing, the slugs are filed away in small wooden galley trays, 12′x6′x¼′. At either end of this tray a small strip of wood is tacked 2′x10″x10″. About 68 slugs, or titles, are placed in each tray and the whole filed compactly in small pigeonhole shelves.

The machine used for making the slugs is the Mergenthaler Linotype machine, and the printing is done on a Multicolor press.

A Farmer's Loading Station

IT is called variously a bag, a sack, a short sack, a gunny sack, even a poke, providing what part of the United States you happen to be in; but for one leading purpose, at least—the transportation of grain from farm to market—its hitherto universal rule is threatened. Grain sacks got up to twenty-five and thirty cents apiece the past season; they are lower at present. But whatever price they command won't trouble this year those farmers who own a loading station.

The farmer-owned small loading station is one of the newest things in the American grain industry. A typical loading station, recently completed at Shafter, Cal., indicates the general character, as well as the merits, of the idea. This loading station has twelve-bin capacity, a total of 72,000 bushels, and was installed by a hundred grain raisers who coöperated.

The bins are of metal and are mouse-proof and weatherproof. Concrete pits are installed close by. Into the pits arriving grain is dumped from wagon or truck, in bulk, and weighed, cleaned, graded and then stored, by elevator. The bins are so arranged and connected that the rapid shifting of grain from one bin to another or to railroad car is easily effected.

Under the Shafter plan, the threshed grain is hauled immediately from field to loading station in bulk. Bags are dispensed with, and the quick handling averts rat and squirrel waste at the farm. The grain remains in the loading station until the farmer wishes to sell, or until cars arrive. Wheat, barley, kaffir and gyp corn are the principal grains of this section, but rice and beans will be placed in this storage as needed.

As regards the financial aspects of the plan, the Shafter farmers say they would have saved the entire cost of the station had they had it available for the last crop. This movement toward more efficient handling of grain at source is likely to spread.

The French Suggest a 200-Mile Gun

Super-Range Guns Are Possible, but Costly and Futile

IT was inevitable that the construction and use by the Germans of a super-range gun, capable of bombarding Paris from a distance of 75 miles would direct the attention of artillerists to a theoretical investigation of the design, cost, and utility of such pieces. The ordnance experts of several nations, including our own, have drawn up tentative designs but, at least in our own case, without any serious purpose of constructing such guns.

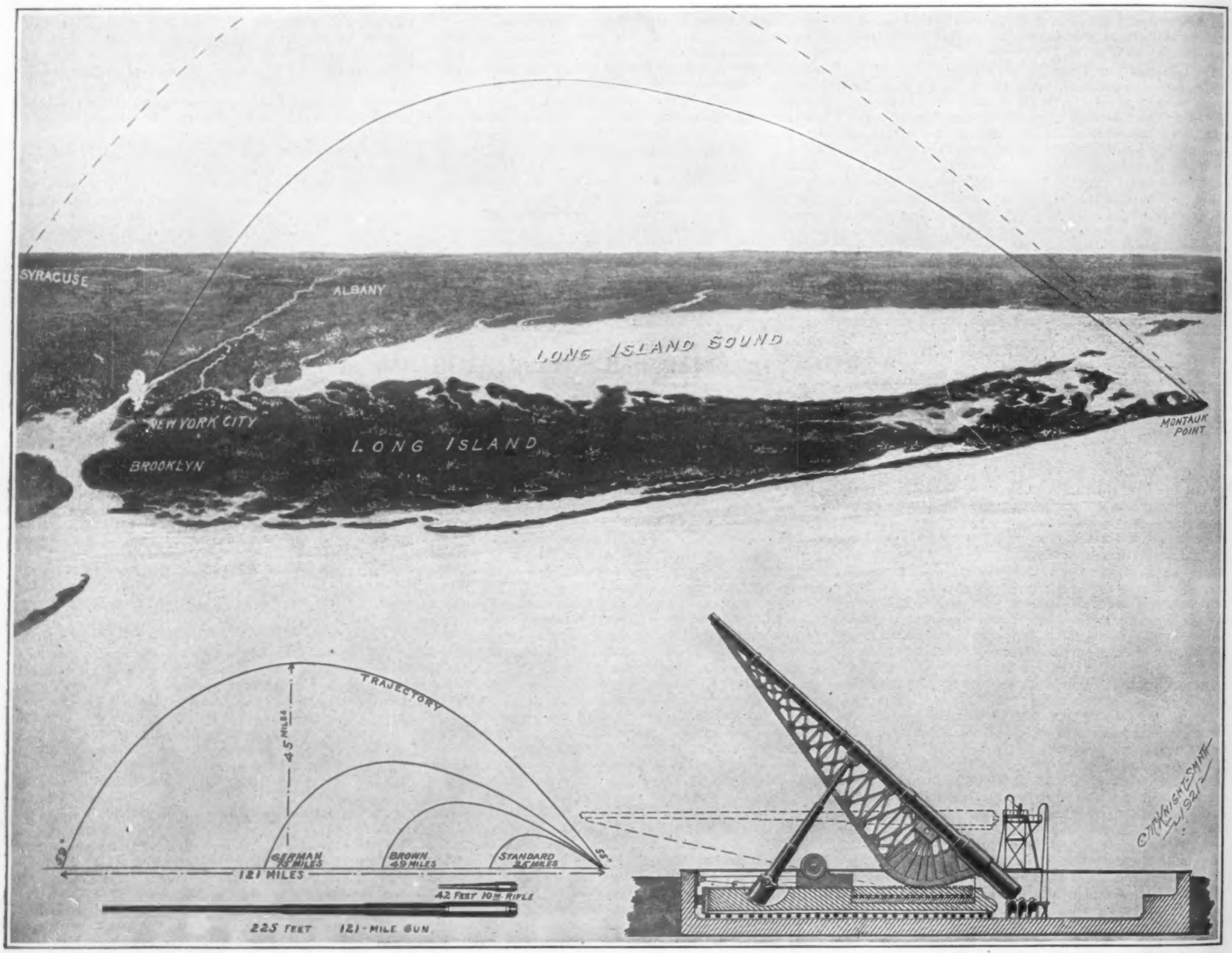
It was more than anything else with a view to proving how costly in time, labor and money is a super-range gun when compared with the damage which it can effect, that the officers of our Army Ordnance designed a gun with a range of over 120 miles. In order to secure accurate ballistic data, the design was worked out just as though it were to form the basis of ultimate working drawings, and the results, therefore, are quite accurate as far as they go.

In the drawings we show the enormous proportions of this gun, as compared with one of the same caliber but of normal length and weight, together with their trajectories and those of the German gun which shelled Paris, and the once much discussed Brown gun. It should be understood that all but the German gun are of 10-inch caliber.

Super-Range Calls for Enormous Weight and Length of Gun

Regarding the limited usefulness of super-range guns, it is sufficient to state that in order to keep the weights within reason they must necessarily be of limited caliber. With the present powders super range can be obtained only with an enormous powder charge and an extremely long gun. The reader should bear this in mind when he studies the table comparing a standard 10-inch rifle with one of 121-mile range. The length goes up from 42 to 225 feet; the weight of the gun from 38 to 325 tons; the weight of the projectile is less, dropping from 500 to 400 pounds; but to secure the enormous velocity of 8500 foot-seconds, the weight of the powder charge goes up from 200 to 1440 pounds. An impressive evidence of the important part played by velocity as compared with mass in the production of energy in a projectile is shown by the fact that, with a rise of muzzle velocity from 3000 foot-seconds to 8500 foot-seconds, the muzzle energy, although the shell is lighter, increases from 31,000 to 201,500 foot-tons.

Our illustration gives an impressive picture of the meaning of a 121-mile range; for if a gun of this kind were to be built and emplaced at Montauk Point, at the easterly end of Long Island and elevated to between 53 and 55 degrees, its shell would leave the muzzle with a velocity of about a mile and two-thirds per second, would soar to a maximum height of 45 miles and would drop into the center of Manhattan Island after covering an airline distance of 117 miles. A reduction of a few miles to bring it upon the island would be accomplished by a slight reduction either in the powder charge or in the elevation. As a matter of fact, variation in the powder and the impossibility of determining the exact atmospheric conditions throughout the trajectory might well cause a variation of a few miles long or short of the calculated range.



Shortly after the war, our Army Ordnance made a study of the dimensions, powder charge, weight of shell, etc., of a gun with a range of over 120 miles. If such a gun were built, it could bombard New York City from Montauk Point. The French are now experimenting with a type of 3-inch gun said to embody new principles of construction, and using a special form of powder, with which in a large gun, they expect to achieve a range of 200 miles. Such a gun could throw a shell from Montauk Point to Syracuse, New York.

A study of super-range guns

Proposed French 200-Mile Gun

In a recent issue of *Army Ordnance*, mention is made of a dispatch to the *Chicago Tribune* from a French correspondent, which gives some particulars of work which is being done by Lieutenant Colonel Maze, of the French Army, in the development of a gun of this type. It seems that the tests of a similar gun, built on the principles of the proposed larger gun, were made at the Belgian Artillery Range at Vivegnis, near Liege, in the presence of several French and Belgian staff officers. The tests were made with a 75-centimeter piece, and they covered a period of six days. The gun is designed on what, according to the dispatch, is called the "turbo"

principle, whatever that may mean. The most intelligible item of information, inasmuch as it suggests the lines along which high velocity are being sought, is the statement that the barrel of the gun will be of "equal thickness from breech to muzzle," and that it can stand a pressure of $21\frac{1}{4}$ tons per square inch. Colonel Maze, according to the item quoted, seems to credit the Germans with having developed a special powder for use in the 75-mile gun "which continues to exert its maximum pressure until the shell leaves the muzzle." The turbo powder apparently is a further development of this type.

Of course, anything which would cut down the unwieldy length of long-range guns is desirable, and nothing would do this more effectually than a so-called slow-burning powder whose burning area, and therefore the volume of gas given off, would increase in the ratio of the increase of the velocity of the shell—that is to say, at the rate of the increase of volume back of the shell. At present the powder pressure in a standard 10-inch gun such as the Elswick piece, shown in our table, falls from 18 to 20 tons per square inch at the breech to probably about six or eight tons at the muzzle. In a gun with a constant maximum powder pressure—that is, a pressure equal to the chamber pressure—existing right through to the muzzle, it would of course be necessary to design the gun with practically equal thickness of metal throughout its full length.

But What About Erosion?

The powder pressure adopted in this gun is over 21 tons per square inch, which is high. Furthermore, since this pressure is to be maintained throughout the travel of the shot down the bore, erosion, which usually is severest at the commencement of the rifling, will in this gun extend at full severity throughout the whole length of the gun. Not only will the temperature be excessive but (and this is of equal if not greater importance) the time during which the earlier portion of the bore is exposed to this high temperature will be prolonged. In fact, no element would seem to be wanting to produce erosion in its most exaggerated form. Possibly Lieutenant Colonel Maze has secured a special quality of gun steel that is highly resistant to erosion. If so, he must be in possession of a quality of gun steel which the maker has been diligently searching for lo! these many years, but without any promise of success.

The Game Not Worth the Candle

But even if the French or any other people should produce a non-erodible gun of 200-mile range, is the game worth the candle? Decidedly, we think not. We were told by the Ordance officer who made the calculations for the American theoretical 120-mile gun, that a single one such piece, with its mount, concrete emplacement, loading gear, etc., would cost $2,500,000. Surely, a 200-mile gun, even with the suggested new powder and other improvement, would not cost, with its mount, any less. So what would we have? A two-and-a-half-million-dollar-investment, capable of dropping, say, a 500-pound shell with 80 to 100 pounds of explosive within it, with no attempt at close accuracy, upon a target 200 miles away. On the other hand, for forty or fifty thousand dollars, it is possible to build a bombing plane which can drop a 2000-pound bomb in the same area and with at least 100 times greater accuracy.

Could Never Have Sunk the "Ostfriesland"

If a 200-mile gun had been built and set up on the Virginian Coast and given the task of sinking the "Ostfriesland," anchored 200 miles at sea, the chances are 1000 to 1 that it would have failed to hit, much less to sink her. Airplane observation of the fall of the shots would have proved of little service. For after the corrections had been radioed in and applied, the slight variation in the quality of successive charges of powder, plus the unascertainable variations in the atmospheric density throughout a trajectory which would rise some 75 miles above the earth, would combine to throw the shell several miles wide of the mark. Only in a perfect vacuum might fairly accurate shooting be done, and even then there would be wide dispersion due to powder variations.

The Power of a Modern Gun and of Thunder

THAT these two subjects are connected in any way is certainly not apparent at first sight. As a matter of fact they are related, and a satisfactory answer to each may be found by following the same line of thought.

The ability to strike decisive blows is the supreme desire of the commander-in-chief of any army, and generally speaking, this can be accomplished only by concerted action on a large scale. If Xerxes could have concentrated the effort of his huge army for a very brief period of time, the battle of Thermopylæ would not have been famous. The capability of delivering such blows, and of doing it repeatedly, is another name for preparedness.

Just as it is proper to estimate the strength of an army in terms of the number of its units, it is natural to describe the power of an army—its ability to deliver decisive blows—in terms of the man-power it is able to concentrate. The modern gun and the high explosive shall make possible this concentration of man-power on a stupendous scale, and while the fact is well recognized, the magnitude of such concentration of power is not appreciated.

For instance, in a modern 14-inch gun a charge of 430 pounds of powder will give a projectile weighing 1560 pounds a muzzle velocity of about 2500 feet per second, and a fair estimate of the time required for the projectile to reach the muzzle is 1/30 of a second. When the projectile reaches the muzzle its kinetic energy is

$\frac{1}{2}$ (1560) (2500^2) ÷ (32.16) = 151,585,820 foot-pounds.

This useful energy has been produced in 1/30 of a second; therefore the rate at which the gun works while the projectile is in the bore is

$$30\ (151{,}585{,}820) \div \frac{60}{33{,}000} = 8{,}250{,}136 \text{ horsepower.}$$

If it is assumed that one horsepower is equivalent to the power of six men, it is clear that during actual performance the gun does useful work at the same rate as would be required by the concerted effort of an army of forty-nine million men. Purely from the standpoint of mathematical mechanics a comparatively small army provided with modern guns is much more powerful than a tremendous army which is not so equipped. By the invention of such engines of destruction as the modern gun and the high explosive shell we have been enabled to wage war, as it were, on margin.

COMPARISON OF A 121-MILE GUN WITH A GUN OF STANDARD RANGE

	Elswick Standard Gun	Theoretical Super-range Gun
Caliber of gun...	10 inches	10 inches
Length of gun...	42 feet	225 feet
Weight of gun...	38 tons	325 tons
Weight of projectile	500 pounds	400 pounds
Weight of powder charge	200 pounds	1440 pounds
Powder chamber pressure	40,000 lbs. per sq. in.	45,000 lbs. per sq. in.
Muzzle velocity..	3000 foot-seconds	8500 foot-seconds
Muzzle energy...	31,000 foot-tons	201,500 foot-tons
Maximum range.	25 miles	121.3 miles
Angle of departure	45 degrees	55 degrees
Angle of fall.....	50 degrees	59 degrees
Summit of trajectory	7.8 miles	45 miles
Velocity at summit	1550 foot-seconds	2600 foot-seconds
Terminal velocity.	1695 foot-seconds	2750 foot-seconds
Time of flight...	1 min. 37 secs	4 min. 9 secs.

Thunder

Any person who has heard the noise produced by the travel of a large projectile overhead or nearby knows that it is very similar to sharp crackling thunder. It is assumed for our purpose that the rate at which the air has been disturbed when we hear this type of thunder is of the same magnitude as the rate at which the air is disturbed by a projectile whose passage through the air makes a very similar sound. This comparison is interesting because the latter quantity can be calculated without difficulty.

Of course the rate at which the air is disturbed by the passage of a projectile depends very largely upon the shape of the projectile and its behavior in the air. If it is poorly stream-lined or travels end-over-end, it transfers a comparatively large proportion of its energy to the air, and in such a case its diminution in velocity is very rapid. Many investigations have been made to determine the form of a projectile which would transfer as little of its energy to the air as possible. Probably the most important information on this subject has been obtained as the result of wind-tunnel experimentation. By this means it has been proved that a projectile may be so stream-lined that the resistance it will offer to the passage of the air is only two seventy-thirds of the resistance that would be offered by a thin disk, equal in area to the greatest cross-section of the stream-lined projectile, exposed head-on to the same current of air.

Using a projectile that would cause considerable disturbance, an approximate idea of what happens is given by the example which follows. A square-end projectile weighing 900 pounds is fired with a muzzle velocity of 3000 feet per second and strikes the earth 5 seconds later with a velocity of 2200 feet per second. It has been fired at a low angle of elevation because the greatest proportional diminution in velocity occurs when this is done. As only a very small portion of the energy is used in heating the projectile, it may be assumed that the energy lost by the projectile in flight is the energy that has been transferred to the air. The violence of the air disturbance is the rate at which this transfer has taken place. The kinetic energy lost by this projectile in 5 seconds is

$\frac{1}{2}$ (900) ($3000^2 - 220^2$) ÷ (32.16) = 58,208,960 foot-pounds; therefore the violence of the air disturbance is

(58,208,960) ÷ (5.550) = 21,167 horsepower.

From this it would follow that the *magnitude* of the air disturbance in thunder is 20,000 horsepower.

Glycerine from Sugar

ABOUT three years ago it was understood that the Germans had made some progress in the manufacture of glycerine from sugar fermentation. The acute shortage of fats necessarily led to an equally acute shortage of glycerine urgently needed in the manufacture of munitions. The usual method of obtaining glycerine hitherto has been that of fat-splitting, or as a by-product in soap manufacture. The fat is "split" into its two main constituents—glycerine and fatty acids, the latter being used for soap-making. In the process of splitting a certain reagent or chemical is used, one of the best known being Twitchell's reagent. Another well-known reagent largely used in Germany is that introduced by Dr. W. Connstein of the Vereinigte Chemische Werke Akt.-Ges., Charlottenburg. Dr. Connstein has therefore been instrumental not only in improving the old method of glycerine production, but, in collaboration with his colleague, Dr. K. Lüdecke, he has done a great deal of work in connection with the new method of manufacturing glycerine from sugar.

In a recent account of his process and of the progress made in Germany generally Connstein pointed out that, even before the war, many users of glycerine and of glycerine products, *e.g.*, dynamite, had earnestly desired to find some other source of glycerine, owing to its increasing cost due to speculation and also to partial monopoly. It is observed incidentally that the trust movement in the English soap industry was tending toward a complete monopoly of the glycerine trade, and that one single English firm controlled at least 14 per cent of the total world production of glycerine. One would have thought the percentage was much higher, but in any case the large consumers of glycerine, especially in America, were becoming alarmed at the upward trend of prices under the alleged monopoly. Whether the new process will be perfectly successful and commercially feasible under normal conditions—assuming that these ever return—it should at least serve as a useful check on undue speculation and monopolistic prices.

The main technical details of the new process are as follows: In the ordinary process of sugar fermentation in a weakly acid or neutral medium the chief fermentation products are alcohol and carbon dioxide (carbonic acid gas) together with small quantities of succinic acid and glycerine as by-products. The chief feature of Connstein's new method is that an alkaline medium is used for fermentation instead of a neutral or acid medium, sodium sulfite being used. By this means the percentage of carbon dioxide evolved is reduced while that of the glycerine is considerably increased. It is claimed that, with the use of sodium sulfite the following yields are obtained from one kilo of sugar: 300 g. alcohol, 50 g. acetaldehyde, 230 g. glycerine, and 420 g. carbon dioxide. In carrying out the laboratory tests 10 liters of water, 1 kilo of sugar, 100 g. yeast, 400 g. sodium sulfite, and a certain proportion of mineral salts serving as a nutrient for the yeast, were introduced into a 12-liter flask, well shaken up, and kept at a temperature of about 30 deg. Cent. After a short time the appearance of carbon dioxide bubbles announced the beginning of fermentation. After 36 hours the sugar has entirely disappeared (Fehling's reduction test), and the liquid is separated from the yeast—which may be used again—by filtration, and the solid portion or filtrate is distilled. The alcohol and acetaldehyde are thus distilled over and removed while the liquid residue is treated with calcium chloride and lime to remove the sulfite still remaining. It is then further treated with soda to remove excess of lime, again filtered, acidulated, and evaporated. In this way a highly saline crude glycerine is obtained which, after removal of the salt, is distilled, yielding a refined product equal in quality, it is claimed, to the best dynamite glycerine hitherto produced.

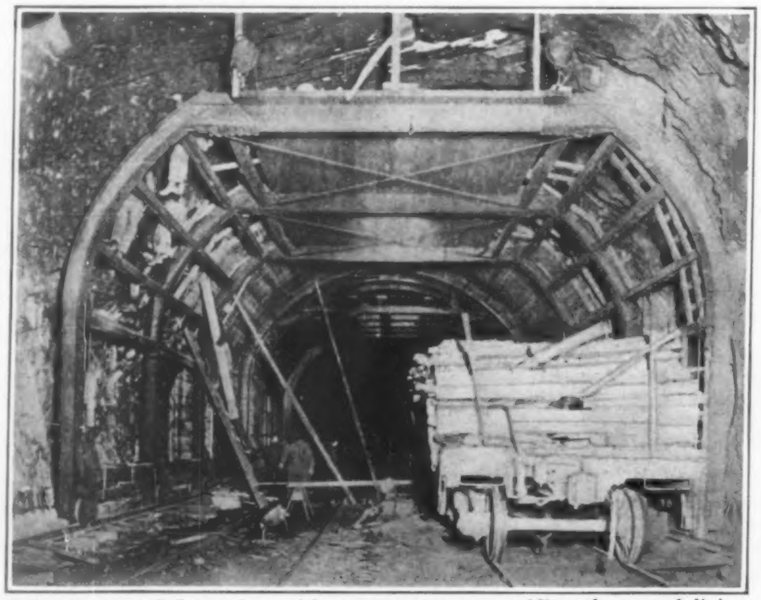
Tunnelling the Selkirks

How the Pneumatic Placing of Concrete Has Solved a Difficult Problem of the Tunnel Builder

SEVEN years ago the Canadian Pacific Railway essayed an ambitious engineering task when it decided to pierce the rocky backbone of the Selkirk Mountains for a distance of five miles for the purpose of creating a double-track tunnel that would save a climb of 550 feet and shorten the existing route by nearly 4½ miles. So rapidly was the work prosecuted that the new line was opened for traffic in December of 1916 and played an important part in moving men and munitions from coast to coast during the remaining period of the World War.

The Rogers Pass Tunnel, as it was originally called, but now known officially as the Connaught Tunnel, runs under towering Mount Macdonald in British Columbia. Its bearing from east to west is in a southwesterly direction. Apart from abridging the journey, the tunnel has made it possible to avoid the upkeep of quite four miles of snowsheds which previously entailed an annual outlay of fully $25,000 a mile.

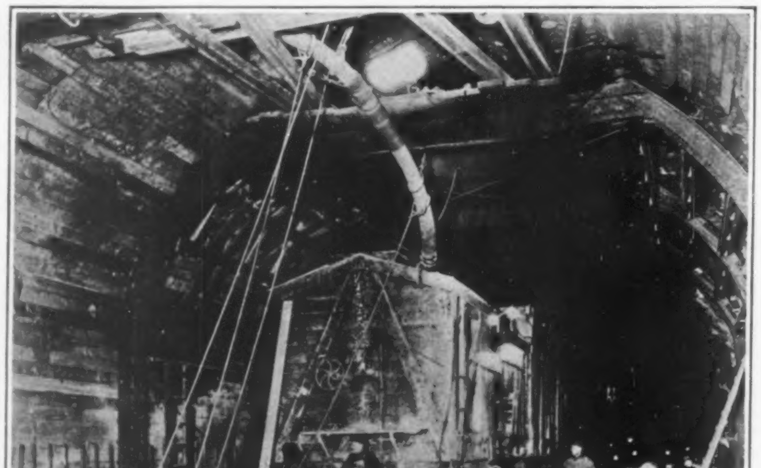
In driving the tunnel the contractors encountered schist, slate, and quartzite. The schist was found relatively easy to drill, even though it proved so tough that more than a single shooting was commonly needed to shatter it. On the other hand, the quartzite was hard enough to make drilling rather slow yet the rock broke readily when blasted. Owing to the nature of the schist and quartzite it was at first thought that it would be unnecessary to line the bore throughout, and therefore only a few short sections were reinforced by concrete soon after the tunnel was driven.



Collapsing metal forms in position preparatory to molding the tunnel lining against the outlying rocky bore

However, not long after the tunnel was in service small rock faults developed at various points. Realizing the enormous weight of the superposed mass, and fearing that the incipient fractures might lead to graver consequences if not arrested, the officials of the Canadian Pacific Railway, in the name of Safety First, wisely decided to have the tunnel walls lined from end to end. But the problem was how to achieve this without blocking traffic. It was essential that one of the two tracks should be free for the uninterrupted passage of trains bound east and west. This requirement, in itself, added measurably to the difficulties of the task. Several attempts were made to meet the conditions imposed, but without success, and consequently the undertaking was abandoned for a while.

Two years ago the matter was turned over to specialists, and these experts, following much study and investigation, concluded that the tunnel could be lined and one track left clear for traffic by adopting the pneumatic method of putting the concrete in place. The ordinary procedure in doing such a job would be to mix the concrete at the portals and then to bring it into the tunnel in suitable trucks or carriers. Arriving at the working stations the material would be hauled up an incline at the forms where its final disposition would be effected by hand. To line a tunnel in this way would, of course, call for the erecting of much scaffolding, and, besides interfering with the movement of trains, might endanger the lives of the men on the job.



The twin-car concrete-placing unit, showing the big six-inch hose in position over the boarded form, forcing the concrete into place

But the question was not disposed of by merely electing to employ the pneumatic concrete placer. The length of the Connaught Tunnel demanded a radical departure in practice. In tunnel work, where the bore is not more than half a mile long, it is at times expedient to set the entire plant just outside one portal and to begin the actual lining at the far end. When this is done the concrete is delivered through a conveying line laid along the floor or invert, and to this line is coupled hose which is carried up and over the forms for the ultimate distribution of the mixture. As each section of the lining is finished the forms are moved backward, and length after length of the conveying conduit is taken out. Thus the point of active operation steadily draws closer to the power and mixing plant.

Experience has revealed that it is neither economical nor efficient to force concrete pneumatically through a pipe for more than half a mile because of the excess amount of compressed air required and owing to the diminished quantity of concrete that will flow from the outlet. Accordingly, the engineers finally chose a portable outfit that can be run upon one track of the tunnel and which is complete, in itself. This obviates the use of a long conveying conduit and has made it possible to do the work with a moderate-sized compressor equipment. The task involved calls for the lining of 20,000 linear feet of the tunnel, and progress is being made at a very satisfactory pace.

As may be readily realized, the engineers have been obliged to employ facilities that would, in addition to leaving one track free, in no wise interfere with signal and other operative circuits, and which would not invite fire hazards. Therefore, the primary source of power is an electric central station situated near Glacier and outside the western portal of the tunnel. The generators located there furnish current for the illuminating system needful for the work within the tunnel and for energizing the apparatus which constitute the pneumatic concrete-placing equipment. The smoke conditions, especially after a locomotive has ascended the tunnel gradient, would much more seriously hamper the operatives but for the installation of powerful flood lights. These lamps permit the illumination to be varied quickly to meet the changing state of the atmosphere, and thus materially shorten the enforced intervals of idleness and are so powerful that their beams penetrate the dense clouds of smoke emitted by the passing locomotives.

The self-contained concrete placing outfit is mounted on two flat cars joined together. One of these vehicles carries an air compressor, a couple of air reservoirs, water tanks, and a bin for the storage of gravel; and the companion car has a similar gravel bin, water tanks, a compartment for the storage of cement, a concrete-mixing machine, and a Ransome-Canniff pneumatic placer from which the concrete is blown through a suitable flexible pipe or hose to the point desired. Between the two cars there is a power-driven bucket elevator which transfers gravel from one bin to the other. The compressor, the mixer, and the elevator are actuated electrically; and the current is fed from the central station through cables which are led for the most part through small parallel tunnels that were cut to facilitate the removal of spoils from the main tunnel at the time of its construction.

Now let us see how the concrete is handled and deposited so as to form a coating or lining against the sides and arched roof of the tunnel. First a footing or foundation course of concrete is laid at each side of the tunnel. When this has set a line of temporary rails is laid alongside both footings, and upon these rails roll the wheels which support the arching, steel, collapsible forms which span the tunnel. Upon the outer surfaces of these forms are secured, longitudinally, heavy two-inch planks, and at the ends of each form other boards are fastened transversely—thus creating recesses into which the concrete can be poured to model the lining. Successively, concrete is deposited on each flank of the form or mold until the side walls have been brought up to the curved sections or haunches. Then follows the completion or keying of the arch. The mold created by a single form has a length of 21 feet.

In order to cast the key section extending along the top of the form from end to end a six-inch hose, connected with the pneumatic placer, is shoved back as far as possible over the form, and the concrete is blown in and the hose gradually withdrawn as the space between the haunches is filled in this fashion. Finally, the mouth of the hose is fastened to a wooden bulkhead, having a suitable opening for the conduit, and the last batch is then forced in to finish the section. An average day's performance consists in blowing one form. As a matter of fact, under ordinary conditions, it is feasible by the pneumatic method to place quite 20 yards of concrete per hour; but in the Connaught Tunnel, owing to the dense smoke that must be dissipated after the passage of a train, it has been found practicable to put in position a somewhat smaller amount of concrete hourly. However, the work is advanced at a rate and with results that could not be secured by any other procedure.

For the sake of those interested in details, let it be said that the electrically-driven compressor has a capacity of 1290 cubic feet of air per minute, and the concrete mixer is able to prepare half a yard of material every sixty seconds. From the mixer the concrete is dropped into the pneumatic placer and from there it is discharged into the delivery hose under an air impulse of 80 pounds pressure to the square inch. Only two men are required in the mixer and placer car—one for each apparatus, and a third is in attendance upon the compressor.

When a form is ready to be filled, the two-car unit

is brought into position beneath it, and then the cars are lifted by eight large jacks just high enough to take the weight of the vehicles off their springs. This is done to give the cars a firm foundation and to prevent their rocking when the compressor is operating at capacity. This arrangement effectually obviates any troublesome vibration. The motor and compressor parts of the cars are housed over to protect the apparatus from the weather and likewise to exclude from them any troublesome dirt and dust due to the prosecution of the work. There are in service six collapsible steel forms, and these make available for pouring daily at least one form while the others remain in position during the hardening of the previously cast lining sections. The storage capacity of water, concrete, and gravel on the placer unit is sufficient to effect the blowing of a complete form without leaving the tunnel for recharging. The shifting of the placer outfit, and the handling of derrick and material cars are done by a gasoline locomotive; and the same engine is used to transport the men to and from the job and also to run a lunch car into the tunnel. This latter convenience has proved well worth while because of the time saved by feeding the laborers on the spot.

The pneumatic placing of concrete renders it feasible not only to meet difficult situations and to dispose of considerable volumes of the material with rapidity, but the equipment is notably effective in reducing labor costs. A few men, after a brief period of training, are able in this way to do much more in a given time than a larger gang relying mainly upon manual effort.

Left: Getting the work of undermining the stack under way. *Right:* What the base of the stack looked like after the fall

Bringing down a particularly stubborn reinforced concrete stack

A Troublesome Problem in Stack-Wrecking

THE city of Spokane, Washington, had a white elephant on its hands in the form of a giant stack, solidly built of reinforced concrete and rising to a height of 210 feet. This old stack was the remains of an old crematory building which, with the exception of this stack, had been demolished when the new modern crematory was built a short distance to the north. This change was brought about through the desire of the Spokane and Inland Empire Railway to widen their yards, and ground was accordingly traded. As a result the white elephant was left standing in solitary and threatening grandeur. The city wanted to wash its hands entirely of the creature, whereas the railroad company was perfectly willing to hand the towering stack over to anybody wanting a symmetrical toy of goodly proportions. As the days passed by, both the railroad company and the city officials became more and more afraid of the threatening stack. If it fell to the south it might destroy several thousand dollars worth of railroad property; if it fell to the north it would almost ruin the new crematory, to say nothing of the possible loss of life that such a disaster might involve. After much heated discussion extending over a period of two years, the courts finally decided that it was the duty of the city to remove the stack. Some contracting firms inspected the stack and figured on the work, but not one of them would assume any liability for damage.

When the city engineering department took up the work, it was discovered that the stack leaned slightly to the south and east. A deadman was anchored north of the direction in which it was hoped to fell the stack, in the belief that in this way the tendency of the stack to go too far south might be counteracted. An attempt to shoot a line over the top of the stack with a gun used for this purpose by the fire department proved a failure—the stack was too high. Then a light scaffold was built up on the inside to a height of 100 feet, a hole made through the shell of the stack, and a ¾-inch cable fastened to another anchor on the inside. The cable was then attached to a manila line, that passed through a double and triple block fastened to a deadman. Then the line was run for 50 ft. at right angles to the drum of a windlass. Thus the windlass and blocks could exert a strain of about 20 tons, yet even with this powerful pull the top of the stack could be drawn over only about one inch.

The next move was to drill a belt of 65 holes around the stack on the side in which it was desired to have it fall, leaving one-third of the circumference untouched except for several emergency holes to be used if necessary. Drilling these holes was difficult work on account of the many reinforcing rods.

Then began the work of blasting away the concrete. The opening on the north side of the stack for the smoke flues was 4 feet wide and 7 feet high. A similar opening was blasted out directly opposite this one. This left two sections to act as columns and support the weight. Then these piers were loaded, and shot at the same time. The stack listed about a foot in the direction of the cable, but failed to fall. It was supported only by the reinforcing rods and one-third of the circumference. Then the steel bars were cut with an acetylene torch, yet even then the stack did not topple, though about 30 inches out of line. Next the emergency holes on that part of the circumference still untouched were shot, and the stack began to fall slowly in the direction of the cable. The cable was rapidly pulled taut and determined the direction of the fall. Finally the portion of concrete left on the back broke, allowing the stack to drop back, and this in turn broke the reinforcing, whereupon the stack fell rapidly. The upper portion of the stack collapsed completely, and buried itself deep in the soft ground.

It took the crew of four men five days to fell the stack, at a total cost of $275 for labor, staging, lines and powder.

The Defectoscope and Elevator Accidents

THE testing of cables in elevators so as to determine any original or progressive defects or flaws therein and thus prevent possible accidents seems to have been realized by recent developments. This is due to the rapid progress which has been made in magnetic testing.

An instrument called a "Defectoscope" has been perfected by Dr. C. W. Burrows, of New York, by means of which it is claimed, any concealed defects in steel wire or cable strips can be immediately located. It is a most interesting device and gives promise of being very useful. Tons of material can be examined for defects due to flaws in the steel, to segregations or inclusions and to other causes without causing any destruction to the material examined.

The instrument consists essentially of the following six elements: A solenoid energized by direct current to effect magnetization of the test piece.

A detector consisting of two test coils having the same number of turns and surrounding the specimen bar whose magnetic variations are to be determined.

A motor to impart a relative motion along the length of the test bar to the magnetizing solenoid and detector which are rigidly connected together. As the detector occupies different positions along the length of the specimen, it is threaded by an induction depending upon the nature of the specimen. If it is not quite uniform, the magnetic induction threading one of the coils and the detector is different from the induction threading the other coil, with the result that the e.m.f. generated in one of the coils differs from that in the second test coil. Consequently, the small differential electromotive force is impressed upon the detector system every time it passes over the magnetic inhomogeneity.

A heavily damped D'Arsonval galvanometer indicating the small electromotive force developed in the detector coils.

A recorder which "reads" the galvanometer and is essentially a photographic film caused to move uniformly across a small slit through whose opening a spot of light is reflected by the galvanometer.

A control box containing all necessary electrical switches, rheostats and instruments.

Magnetic testing being non-destructive of the material has the advantage of being applicable to every piece if necessary, but by the proper selection of the characteristics to be measured a single determination—as to whether or not a test piece is of the same magnetic characteristics as an original standard sample—may be made to settle the question.

In addition to the work which has already been done on rails, wires, rods and cables and upon specimens having circular symmetry such as ball races, balls and milling cutters, there is great opportunity for additional developments in the use of this instrument along similar lines. Tires, gear rings, roller bearings, disk blanks and circular saws, are important steel products whose magnetic examination gives great promise. Specimens such as drills, reamers, taps and other small tools have received but little investigation and yet are of sufficient importance to warrant consideration. Small irregular shapes, such as cutlery, graver's tools, small machine tools and chain links, need investigation. Large, irregular shapes may present difficulty, but in many cases there is sufficient promise of success to justify investigation. At the present time there is no satisfactory method for the examination of crankshafts, steel bottles, and band saws and a great variety of miscellaneous shapes. Other problems for which the magnetic test may yield a satisfactory solution are the degree of perfection of welded joints and study of strains induced in the various elements by the repeated stresses of the service tests.

Recording Locomotive Operation

By Charles N. Winter

An indicating and recording machine, called a loco-recorder, designed to indicate to the engineer the speed at which the locomotive is travelling and to give a permanent record in the bargain, of speed and direction of motion, whether forward or backward, and to record the time consumed in stops, at stations or elsewhere, is shown in the illustrations. This instrument is intended for use in road service and makes it possible to eliminate much of the danger incident to excessive speeds on curves or wherever speed restrictions are necessary. A dial pointer indicates the speed to the engineer and the entire story of operation is clearly recorded on a tape that is easily read. The duration of stops and slowdowns is clearly shown by placing this record against a keyboard having all of the stations, towers, sidings, or other points on a division at which speed restrictions are necessary, shown in the same proportions as the graduations on the tape. Such an instrument is especially valuable at the present time because of the extremely large and heavy locomotives and cars now in use. It prevents the unnecessary wear and tear on rolling stock and tracks caused when locomotives that are intended only for slow and heavy service are run at express train speeds.

A portion of this instrument is built on the same lines as a speedometer, centrifugal force actuating a dial pointer which indicates the exact speed at which the locomotive is moving, while two pencils, operating independently, record the time and the speed, on the tape.

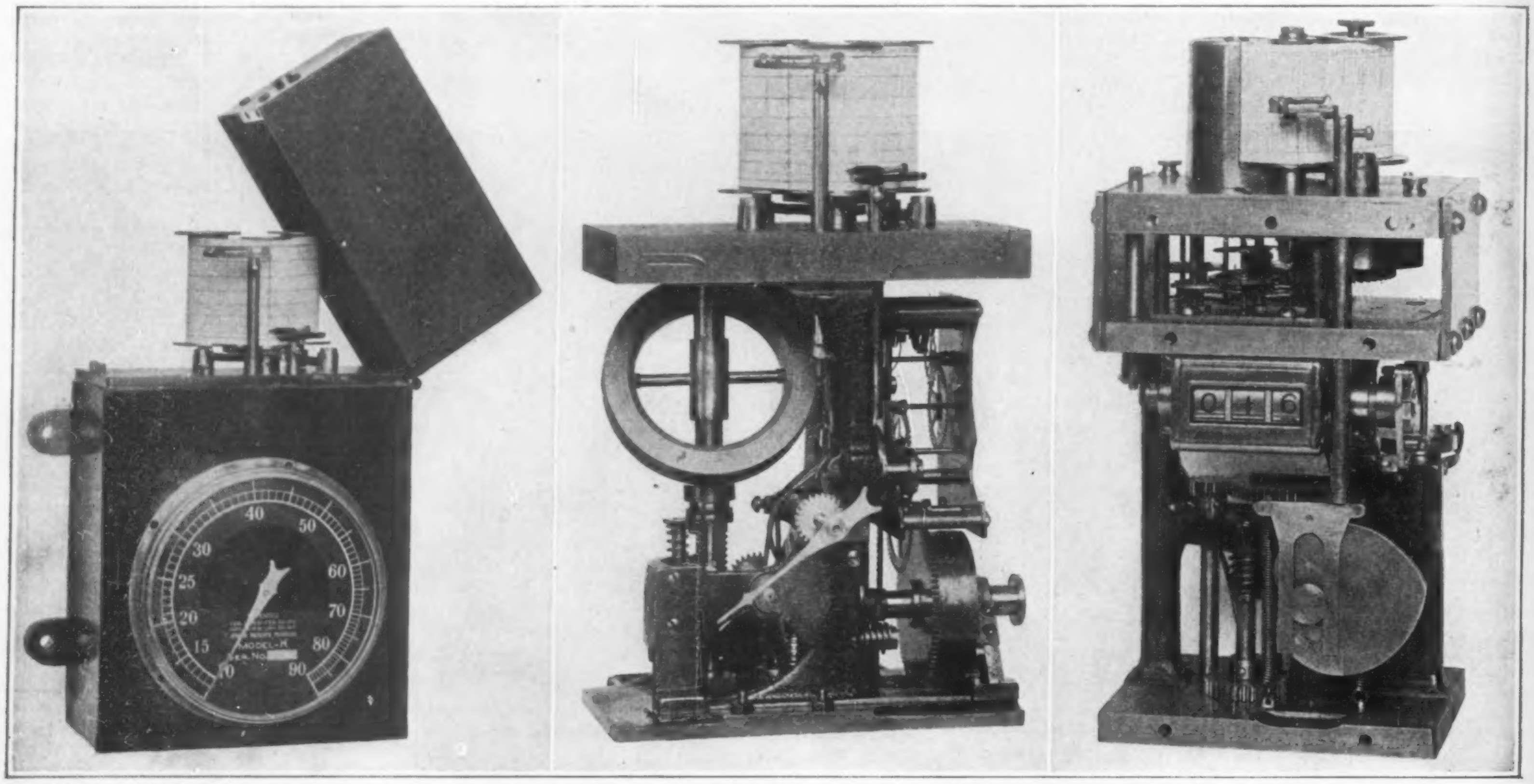
The tape is driven by a connection with one of the locomotive driving wheels, moving with it at the rate of a half inch to one mile of locomotive travel.

This tape is calibrated horizontally in miles per hour and vertically in miles of track, with heavy lines every five miles.

The movement of the speed pencil across the tape is in direct proportion to the speed of the locomotive and it returns to zero at every stop. Each change of speed is instantly indicated on the dial and as the dial and the recording mechanism are interlocked the acceleration and deceleration are recorded on the tape and easily read at the end of the run.

A clock mechanism operates the time pencil, which moves across the tape in 10-minute strokes. This pencil makes an angular line when the locomotive is in motion, the angle depending on the rate of speed. When the locomotive stops the pencil makes a straight vertical line on the tape, the length of the line showing the duration of the stop in the ratio of 3-16 inch to one minute of time.

Besides being a safeguard in train operation, the advantage of using such an instrument lies in the fact that a complete record of the operation of several locomotives may be obtained for comparison, providing an accurate basis on which to make any changes that may tend to improve the service. A similar instrument has been designed for use on switching engines. This instrument records the performance of the locomotive on a tape in the same manner as in road service but as excessive speed is not often attained in switching service, the speed indicator has been omitted. An odometer automatically records the mileage, registering every 35 feet. It can be set back to zero whenever it is desired to do so. The use of such a machine gives a complete record of the operation of a switching engine that could not easily be obtained in any other way and makes it possible to compute the idle and working time of a locomotive in such service.



Left: The externals of the instrument used in general service. *Center:* The internal mechanism of this piece of apparatus. *Right:* The recorder for switching locomotives, minus the speedometer feature.

The device that tells the engineer and the division chief all they need to know about the operation of the locomotive

The True Physiological Nature of Shock

It has long been supposed that the traumatic shock from which wounded men suffer is a nervous phenomenon. This view has recently been combatted by a French surgeon, Dr. E. Quénu, who holds that this so-called "shock" is really due to intoxication, *i. e.*, to the absorption by the blood of toxic albumens proceeding from crushed and bruised tissues. This is not to be confused with poisoning produced by infection. As a matter of fact, the shock is produced at a moment when possible infection is practically negligible. Furthermore, shock exists in many cases when infection is out of the question, because of the fact that there is no external wound. Such cases are well known. For example, a man was imprisoned by the falling timbers of a house wrecked by an explosion, his thigh being caught between two beams, but neither wounded nor fractured. It was not possible to rescue him until after 24 hours had elapsed. During this time he exhibited no signs of shock. Upon being rescued, however, he at once showed the symptoms of shock and shortly died. This case is explained, according to Dr. Quénu, by the fact that the subcutaneous tissues had been bruised, with a consequent production of poisonous albumens. The latter, however, were prevented from entering the circulation, owing to the compression of the thigh. As soon as this compression was removed the circulation was re-established, the toxic albumens were distributed throughout the body and at once reacted upon the nervous system as a whole to such a degree as to produce the well-known phenomena of shock.

But if shock were of nervous origin, it should make its appearance very early, while, on the contrary, it is often tardy in appearance. This is because a certain lapse of time is required for the toxic albumens to be formed and distributed in the organism; when their distribution is prevented there is no shock. This may be illustrated by two cases. Two wounded men, whose wounds were accompanied by bruises, had tourniquets applied to prevent hemorrhage. One of the wounded men underwent an amputation *above* the tourniquet, which remained in position; no symptoms of shock appeared. The other man was operated on *below* the tourniquet, which was removed later; in this case shock made its appearance. According to Dr. Quénu, this difference of result was entirely natural, since in the first case the toxic albumens were removed before they had time to be distributed in the body, while in the second they were absorbed in the organism and poisoned it.

Another interesting thing is that the degree of shock is in no wise proportional to the gravity of the wound. Thus, a man may have his legs carried off by an exploding shell without suffering shock. His wound is quite open and the toxic albumens are absorbed by the bandage. Another man may have a wound which is purely muscular, but of large extent and depth. In this case there will be shock, because the poisonous albumens will accumulate in the bruised tissues instead of being drained away.

The practical conclusion to be drawn from these observations is that the wounds should not only be cleansed as soon as possible, but that all the bruised tissues, which are the sources of toxic albumens, should be cut out. The existence of these toxic albumens or, as they are sometimes termed, toxalbumens is by no means a matter of mere theory. The symptoms of shock can be produced by injecting them into an animal which has not been wounded. A surgeon named Dale produced such a result with histamine, and he further observed that wounds accompanied by extensive muscular lesions produced poisons similar in character to histamine.

Another French investigator, M. P. Delbet, has demonstrated the toxicity of bruised muscles. His experiments upon animals have shown, moreover, that the toxalbumens of carnivorous animals are more poisonous than those of animals which feed upon vegetable substances, and this observation led him to inquire whether shock was not favored during the war by too large a percentage of meat having place in the regular diet of the troops.

The Truth About the Devil-Fish

Correcting Various Erroneous Views Which Have Been Spread by the Highly Interesting if Inaccurate Fictionists

By William Crowder

WHEN Victor Hugo, in "The Toilers of the Sea," penned his immortal description of the combat between a man and a "polyp," he rendered one of the most fascinating if not strictly credible accounts to be found in romantic literature. Unfortunately, Hugo was not a naturalist and his scientific knowledge was somewhat primitive; as a result both his description of the devil-fish and of the man-hunting attributes of his monster have no counterpart in fact. Still, imperfect as this description is, it at least had the merit of giving publicity to a class of animals which would probably have remained little known to few other than professed naturalists, for, as it was once truthfully observed, it has done more to acquaint the world at large with the existence of cephalopods than all the learned and careful writings of the men of science.

Since this classic instance of the employment of these creatures as an aid to excite the imagination, other fictionists with more elaboration, but less art, have continued to use this literary device; consequently the devil-fish and its allies have achieved an evil reputation and are generally conceived to be the most fearful and dreadful of invertebrate animals.

Naturalists, however, have a quite different story to tell; from them we learn that these monsters are not so black as they are painted. Their reports though less thrilling are none the less most interesting, and moreover they reveal traits in these creatures which are among the most extraordinary to be found in the lower animals.

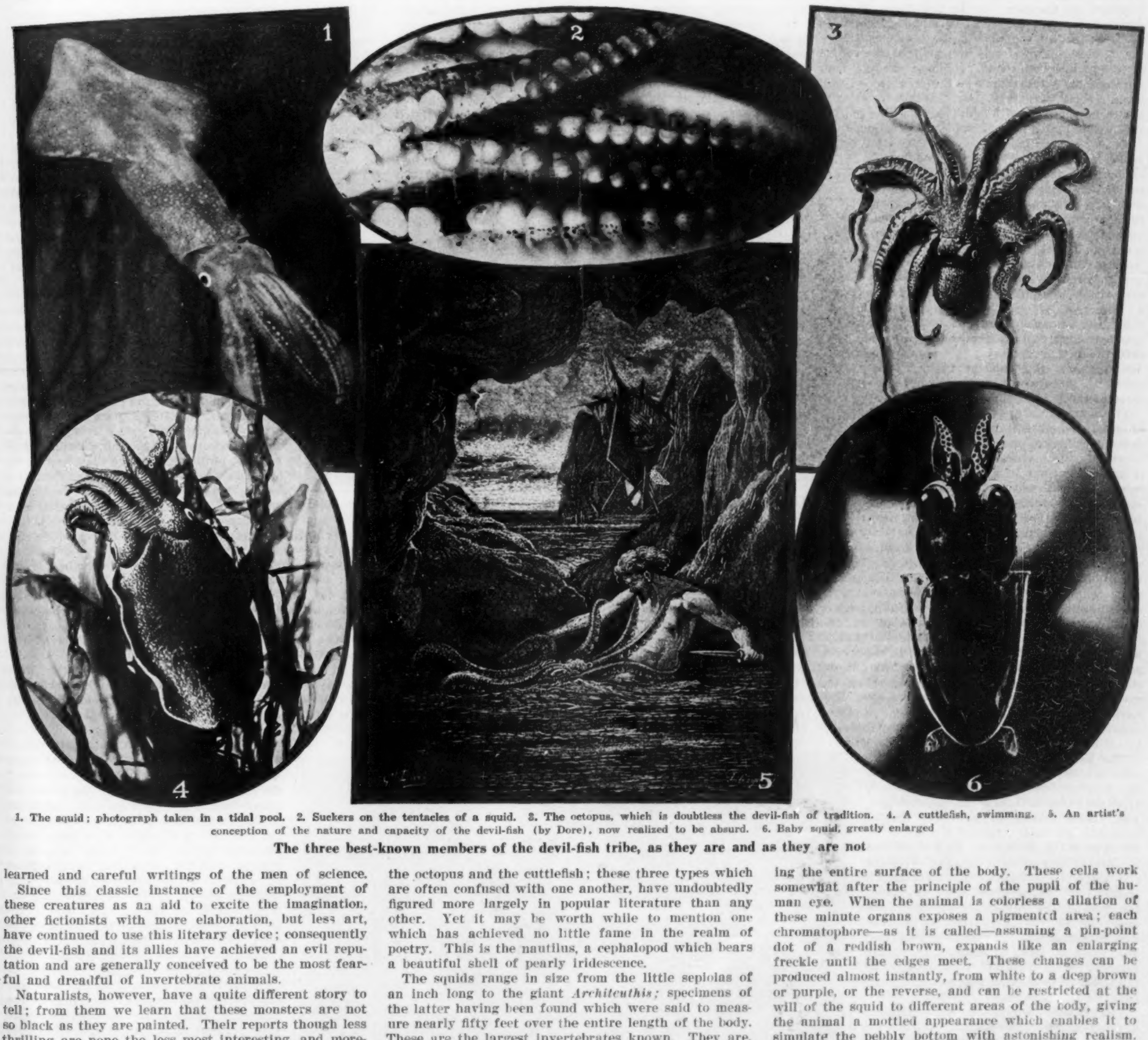
The devil-fish—or octopus—and its allies compose a group of animals which in the language of science is termed the *cephalopoda*. The cephalopods are highly organized molluscs—being very close relatives to the clams, snails, slugs, etc.—and are distinguished primarily by their tentacular sucker-arms arranged in a radial manner around the mouth. All are carnivorous, and subsist chiefly on fishes and crustaceans which they catch with the aid of these members. There is some evidence, however, that certain squids are part, if not wholly, vegetarian in their diet, for several large specimens captured off Catalina Island, California, were found to have their stomachs full of sea weed.

The best known members of this group are the squid, the octopus and the cuttlefish; these three types which are often confused with one another, have undoubtedly figured more largely in popular literature than any other. Yet it may be worth while to mention one which has achieved no little fame in the realm of poetry. This is the nautilus, a cephalopod which bears a beautiful shell of pearly iridescence.

The squids range in size from the little sepiolas of an inch long to the giant *Architeuthis;* specimens of the latter having been found which were said to measure nearly fifty feet over the entire length of the body. These are the largest invertebrates known. They are, however, extremely rare, as very few have even been found; and even of these, none was in perfect condition due to the attacks of whales and the violence of storms. In this connection it may be observed that sperm whales live almost entirely on cephalopods which they destroy in countless numbers in their excursions through the open sea. The giant squid lives only in the deep sea and has never been seen alive near the waters of the shore.

The common squids of our shores are not unlike the giants in appearance except for size. Rarely do they attain more than a foot and a half in length. They are rovers and often travel in shoals, following schools of young fishes or minnows. Often, however, a lone individual will stalk its prey, and as it swims it presents some remarkable color changes. This peculiar property of changing its color, which is also shared by other members of the group, is due to pigment cells covering the entire surface of the body. These cells work somewhat after the principle of the pupil of the human eye. When the animal is colorless a dilation of these minute organs exposes a pigmented area; each chromatophore—as it is called—assuming a pin-point dot of a reddish brown, expands like an enlarging freckle until the edges meet. These changes can be produced almost instantly, from white to a deep brown or purple, or the reverse, and can be restricted at the will of the squid to different areas of the body, giving the animal a mottled appearance which enables it to simulate the pebbly bottom with astonishing realism.

Perhaps few circumstances are more startling than one's first sight of the squid lying on the bottom after it has changed to a deep brown, contrasting strongly

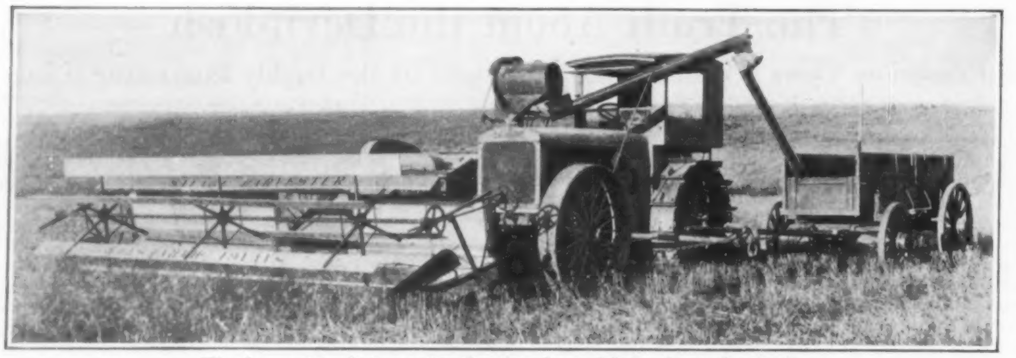


1. The squid; photograph taken in a tidal pool. 2. Suckers on the tentacles of a squid. 3. The octopus, which is doubtless the devil-fish of tradition. 4. A cuttlefish, swimming. 5. An artist's conception of the nature and capacity of the devil-fish (by Dore), now realized to be absurd. 6. Baby squid, greatly enlarged

The three best-known members of the devil-fish tribe, as they are and as they are not

against the substratum when suddenly it almost dissolves from view by turning to a ghostly white and slinks away like a specter of its former self.

In addition to this method of making themselves invisible, these animals utilize an organ which produces an effect similar to the smoke screen employed by naval vessels. This organ is the ink bag. When an individual is irritated or pursued it ejects a black substance which clouds the water and disconcerts or confuses its enemy.



The harvester that carries the thresher with it about the fields

The mode of progression used by the squid is no less curious than the features just described. Its body may roughly be compared to a hydraulic pump wherein the water enters at one aperture and is expelled at another. It is the force of the water directed through the vent, or siphon, located just below the head at the base of the tentacles, that propels the animal. This force is produced by contractions of the mantle which is the loose sac-like body that envelops the vital organs of the creature. Usually the squid swims backward, that is, tail foremost; but it can swim forward with equal facility simply by turning its flexible siphon in the opposite direction.

Strangely enough the octopi are the cephalopods which have always been featured in the exploits of journalistic tales; yet these individuals neither have the aggressiveness nor do they attain the huge proportions of some of the squids. It has been extremely infrequent that an octopus has been found with tentacles measuring over ten feet long. And even when those large specimens were caught they showed no disposition to fight but invariably made a desperate struggle for liberty. Although these animals are possessed with great strength and are armed with a powerful weapon in the form of a sharp parrot-like beak, they appear to be unconscious of their power and seem never to attempt using it in their defense.

The stripping machine that harvests the seed and leaves the grass

The octopus is one of the most timid of animals and will retreat when a human being comes near it. It can be observed in its natural habitat, however, if one is cautious in approaching it; for, in common with most wild creatures, they recognize as inimical only moving objects. The difference between an octopus and a squid may be stated tersely by saying that the former has eight long tentacles and a short body, while the latter has ten short tentacles and a long body. It is partly due to these relatively long arms, however, that the octopus gets its unsavory reputation; for without a doubt these long writhing organs make it the most hideous and gruesome of all creatures. It lies secreted in rocky crevises, awaiting its unwary prey. When some unlucky fish or crustacean passes near, the lurking monster throws out its tentacles with astonishing rapidity; and when once the suckers, which line the inner surface of the arms, have touched the victim, there is no escape. It is carried to the mouth where it is despatched at once by a bite through the back.

The hard and stony stare of cephalopods doubtless has also much to do with the general impression of horror which attaches to one's sight of these creatures. The visual organs of no other animal have the ghoulish expression that is in the eyes of the devil-fish. This weirdness is further accentuated by the writhing and tortuous movement of the animal's body as it crawls from place to place; for, unlike the squid, it seldom swims about in its travels. It can swim very well, however, when the occasion requires; and, when so doing, it employs its siphon together with rythmic contractions of the web-like membrane which connects the bases of the tentacles.

The female octopus is an extremely devoted parent. She usually selects for her nest a recess in the rocks below the tide level, and guards the eggs with all the jealousy of a mother hen. When first laid, the eggs are small oval bodies, somewhat resembling translucent grains of rice growing around a common stalk. Each egg is separately attached to the stalk by a short peduncle, the whole being not unlike a bunch of tiny white grapes. The average number of eggs in the brood of a full-grown female is fifty thousand. The parent aerates them occasionally by manipulating the clusters with her tentacles and frequently directing a current of water upon them with her siphon. Seldom does she leave the nest, and then only for a short period when it becomes necessary to search for food. The brooding period lasts about seven weeks; at that time the young hatch soon leave the natal precincts to begin an independent life free from maternal care. The babies are quite different in appearance from the adults, having undeveloped arms which decorate the head like a raked crown.

The cuttle-fish is a cephalopod which in appearance has more of the attributes of the squid than of the octopus. That is to say, it has a proportionately long, but somewhat flattened, body and ten arms. Eight of these arms are relatively short; it has, however, two long slender tentacles which are devoid of suckers except on the club-shaped region at the ends. These organs are generally kept retracted close to the head and are brought into play only when capturing food. These animals are abundant in tropical waters. They are harmless and inoffensive creatures and never attain the sizes of the larger devil-fishes. It is from this animal that the india ink and sepia of commerce is obtained. The "cuttle-bone," which is a familiar object in the cages of canary birds, also comes from this individual. This is not a bone but is the internal shell secreted by the animal.

Now it cannot be gainsaid that the cephalopods above described are hideous and forbidding in aspect; are, in certain instances, of unusual size, and are ruthless in the capturing of their natural prey. But the writer submits that there is nothing in these indictments which should indicate that they have a predilection for attacking humans. In his own contact with these animals, in the waters of three oceans where they abound, he has gathered no evidence, either by actual observation or authentic testimony, that devil-fishes, regardless of size, have shown anything but fear at the sight of man.

So generally established among a misinformed public is the dread of devil-fishes and their allies that even the most venturesome will shrink from bathing in waters which are known to be frequented by them. Indeed, this prejudice is even maintained in more restricted environments; for in an actual test recently made in a marine laboratory where an octopus with arms a foot long was confined, out of scores of visitors who passed the tank and were asked to touch the animal, less than two per cent did so, although in each case the request was made after earnest assurance was given that the devil-fish was harmless and would merely squeeze the hand.

Harvesting and Threshing in a Single Operation

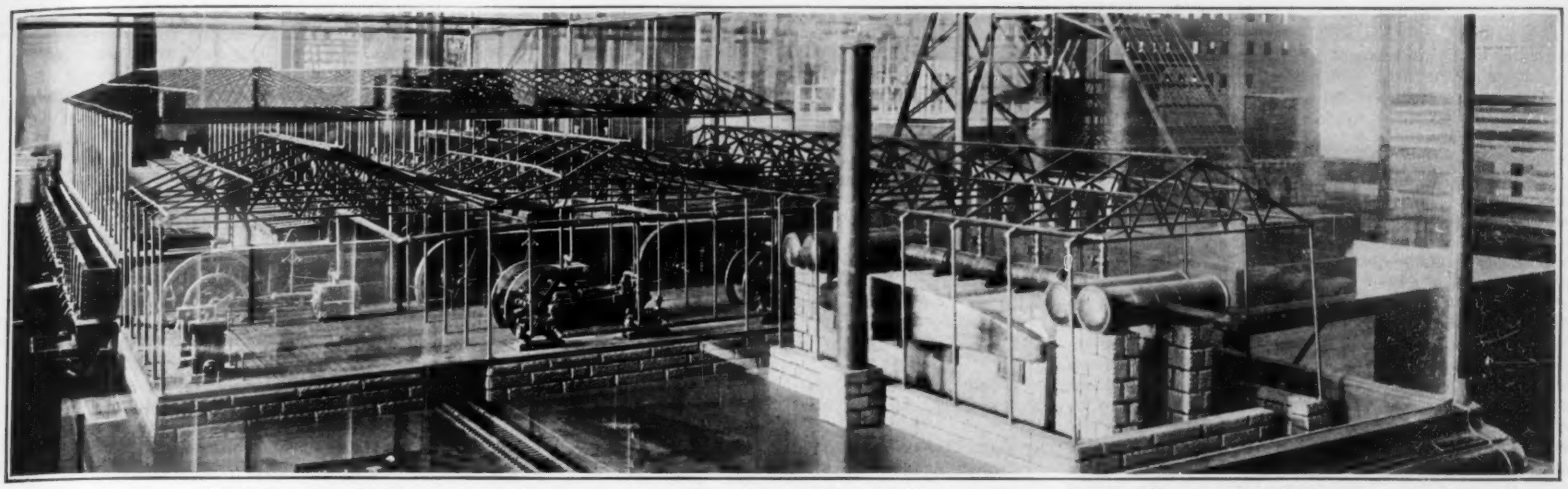
AMONG interesting farm apparatus put on the market recently, a high place must be awarded to the combined harvester and thresher illustrated at the top of this page. By an arrangement for making the tractor a part of the harvester-thresher, yet permitting its removal for other work, the auxiliary motor and pulling hitch are dispensed with at a heavy saving. The outfit cuts a swath 16½ feet wide, at a maximum speed of 3½ miles per hour, giving it a capacity of seven acres an hour. A feature is an arrangement of the threshing cylinder and blast tube which makes it possible to blow off a high percentage of the chaff before the straw and grain pass to the separator, so that the work of the latter unit is greatly lightened and its weight and cost lessened correspondingly. The outfit is claimed to take the place of all farm machinery used in wheat raising, with the obvious exception of the tillage tools.

The manufacturers conservatively estimate that with this device a man and boy can raise and market 600 acres of wheat, which means that a great saving in labor is effected.

Harvesting Without Reaping

CARPET grass is the best pasture grass grown in the coastal plain region of the Atlantic coast and Gulf states. Heretofore it has been extremely difficult to harvest the annual seed crop and hence the amount of available seed for sowing purposes on the market has been very limited and the price has ranged from 75 cents to $1 a pound. The stripping machine shown in the accompanying illustration is an efficient and newly designed implement for saving carpet grass seed. By means of mechanical fingers connected with the revolving cylinder at the rear of the machine, the seed is stripped from the plants in the field and elevated by conveyors to the front of the harvester where it is deposited in sacks. The existent high prices and the keen demand for the seed make it profitable for every farmer who grows much carpet grass to own and use one of these modern harvesters.

Another type of machine which strips the seed from the standing stalks



Model, costing $5,000, of a complete ore-concentrating plant, which contributes to the success of college work in this line

The Miner's Dump-Heap Goes to Work

How Values Are Being Recovered from Ores That Were Once Discarded

By M. A. Henry

THE American mining industry is rapidly approaching an economic crisis, if, indeed, it does not already face one. In this country there has been no exception to the general rule that the richest ores are first used. The problem now is to produce metals from the remaining ores, constantly growing lower in grade, at a profit in competition with ores from richer but distant fields.

Obviously there is a vanishing point at which mounting cost of production meets haulage costs. Here profit to the local producer vanishes. There is another important element in the situation: the greatly expanded needs of American industry. A few years ago it was a very simple matter to supply the moderate requirements of industry at a good profit from a few rich ore deposits. But the amount of raw material used in American industries has increased at such an astounding rate that now more than 75,000,000 tons of iron alone are consumed each year, and many more millions of tons of copper, nickel, zinc, lead and other metals.

Mining is one of the oldest of the industries, but it has made very slow progress down through the ages. It is rather astonishing to find that many of the mining methods and machines used as "standard" today have been used for hundreds of years. But the economic situation as regards mining has developed so far in this country that already it is no longer possible to produce metals at a profit using the methods of twenty years ago.

The mining industry is thoroughly awake to the crisis and is meeting it—successfully. How it is being done ought to be a revelation to the leaders of every other industry.

Two broad lines of action are being followed. It is recognized that the essential needs are, first of all, highly trained men to meet and overcome the individual technical problems; and second, better types of machines. No two ore deposits are alike and therefore no two mining problems are alike. This complicates matters: the mining and extraction of ores cannot be expedited by any of the quantity production methods which have been developed in, say, the automobile industry. The great universities of the country have been appealed to and cooperation between the industries and the mining schools has been carried out to a rather remarkable extent.

There are three essential steps in the process of mining: first, the actual digging of the ore; second, concentration to remove much of the useless material, and third, smelting to obtain the metal. No great improvement in digging methods has been found in centuries, although of course modern machinery eliminates some of the old-time labor. The third process, smelting, has neither been basically changed nor greatly improved.

It is the second process, that of concentrating, or "dressing" the ore which offers the widest field for investigation and invention. In recent years very great progress has been made and indications are that even larger results are in sight. It is on this battlefield that the American mining industry will fight its decisive engagement.

Most of the common metals occur in the earth in chemical combination with sulfur and are known as sulfides. Sulfides are usually associated with various worthless minerals, as quartz and other silicates, limestone, etc. Before the sulfides can be economically treated to obtain the metals as large an amount of the waste or "gangue" as possible must be removed, without at the same time losing too much of the sulfides. This is usually accomplished by mechanical treatment and the result is a concentrate which may contain as little as 35 per cent or as much as 98 per cent of the total metallic content of the ore and more or less worthless material, according to the character of the ore and the efficiency of the process.

The oldest and still the most widely used process is some form of gravity concentration, based on the fact that the particles of ground ore containing metal are heavier than the gangue. Almost everyone is familiar with the "panning" method used by prospectors and the early gold miners. This is the simplest form of gravity concentration. A quantity of ore is placed in a pan of water and agitated. The metal sinks to the bottom and the useless material can be scraped off the top.

There are many methods of doing this mechanically, the most common being a flat and slightly inclined table, over which the ground ore is carried by a sheet of flowing water. The surface of the table is corrugated and the heavier valuable particles collect in these "riffles" and are carried by a shaking motion of the table to one end and are flushed off into a receptacle.

Gravity concentration is an effective and economical method of concentrating ground ores when the particles are larger than 0.01 inch in diameter. When, however, the particles are smaller than this, and especially in the case of very finely ground particles which are designated in concentration practise as "slimes," gravity concentration falls down and the "flotation process" is used. This is the newest revolutionary development in mining and has been given much attention recently. In many of its ramifications the process is not yet thoroughly understood and it offers a profitable field for research. It operates essentially as follows:

The finely pulverized ore is mixed with water in the proportion of three of ore to five parts of water by weight and there is added thereto a small quantity of oil and, under certain conditions, some inorganic chemical compound such as sulfuric acid or an alkali. A gas (air) is then introduced into the mixture, usually either by agitation or through a porous bottom in the containing vessel. As the result of either of these methods of treatment, although by a chain of totally different phenomena, a froth is formed at the surface of the mixture carrying a large proportion of the valuable mineral. This froth is removed by skimming or overflow, broken down, and the mineral collected. As much as 98 per cent of the total mineral content of the ore may be collected in this manner.

The theory of the process is not yet clear, but it has been shown that the introduction of the gas causes the formation of bubbles with a skin of oil and that by some curious force of attraction the particles of mineral cling to the bubbles and rise with them while the gangue is not affected and settles to the bottom.

Aside from the development of the flotation process, mining engineers, however, have devoted their energies principally in recent years to improving existing machines and devising means for handling larger and larger quantities of ore to obtain a proportionately smaller quantity of metal. One engineer discovered, for instance, that by a slightly different arrangement of the "riffles" on the shifting table described heretofore he could increase the capacity several times. The result has been a great saving in labor cost to the large plant. It places the small plant, where only one or two machines are needed, at a disadvantage because one skilled attendant can care for a large number of these machines and the large plant is able to distribute the expense over a larger tonnage. In the very large ore dressing plants there is little or no handling of the ore by hand, while the small plant cannot afford this expensive equipment for its small batches of ore. In slack times the large plant can cut down overhead by operating part of the plant at capacity, whereas the small plant must carry the same overhead for small production as for capacity runs. Another very important consideration, often overlooked, is the fact that the large plant, because of its proportionately smaller labor cost can afford more highly trained men who are able to devise many economies.

The result of all this has been a welding of the companies engaged in mining into larger units, and this process of amalgamation, we may fairly assume, has not reached its limit. The cost of a modern concentration plant may run into millions, and the small concern which cannot afford the most modern equipment is likely soon to find itself forced by economic pressure into combination with other concerns.

But in a final analysis the problems of machinery and plant are secondary to the problem of obtaining highly trained men, especially executives. There has developed in the mining industry an insistent demand that practical experience shall be grounded in academic training. To this end the mining companies themselves have begun to cooperate with the universities in the training of men.

One of the newest and best examples of the effect of this policy is found at Columbia University. The ore-dressing laboratories there are just now undergoing an entire building, largely from funds provided by mining companies and individuals interested in the industry. Thoroughly modern machinery is being installed and much of this has been given outright or loaned indefinitely by the makers.

The installation of the machinery is being made on a newly devised "unit plan," by which it is possible to make a large variety of combinations of machines with only a few hours' labor for each change. This laboratory plant is much more flexible and therefore more useful than the old style laboratory in which a single complete ore-dressing plant of approved type was installed.

For each full-size machine there is a working laboratory model, which not only serves to demonstrate the principle involved, but is effective in treating batches of a pound or two of ore. Because of the limited space the handling of ore for the large machines is mostly hand work, and as tons of ore must be handled at each run, the models serve the daily classes and the large machines are operated only at intervals.

Since no two problems in ore dressing are alike, train-

ing usually takes the line of a thorough grounding in fundamental principles, with each lesson pointed, where possible, by an experiment with a typical piece of mill apparatus. The man who plans to be a specialist receives more intensive training.

"His calls in later work," explains Arthur F. Taggart, professor of ore dressing at Columbia, "will come only because others have failed in the solution of some particular problem, which usually means that it is new and difficult. Hence his training must teach methods of attack and aid the development of the student's imagination, initiative and analytical ability. For such a student research into some difficult and slightly explored field is the best of training."

A very comprehensive plan for cooperation between the Columbia School of Mines and the industry has been worked out. The scheme most favored is the foundation by an interested concern of an industrial fellowship, either temporary or perpetual. A student desirous of taking advantage of this opportunity is chosen by consent between the company and the instructor. The student is preferably a candidate for a degree, and the subject of his thesis is chosen by the company, again with the approval of the instructor. Between a half and a third of the student's time is spent on the special subject assigned and the remainder on collateral subjects designed to broaden his technical education. The usual understanding in such a case is that the student shall enter the employ of the company upon graduation. The student, for his part, binds himself not to demand, because of his special training, more salary for the first year than is paid other men of equal training along general lines. At the conclusion of the first year both parties are free to conclude any desirable arrangement.

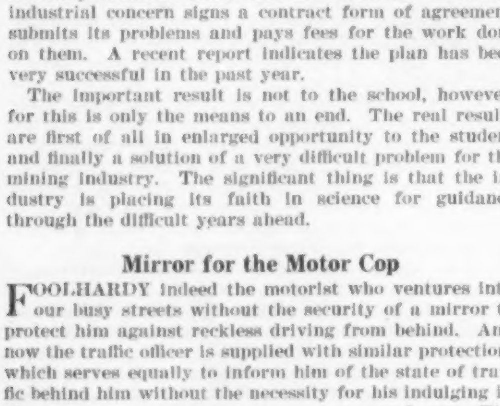
Another plan of less permanent character is one whereby the company may hire one of the students to work on a specified problem, under the guidance of the instructor. When the instructor acts in a consulting capacity, in this case, he also is compensated. In all cooperative investigations involving the work of a student, it is insisted that the results be available for publication.

While the Columbia ore-dressing laboratory is now one of the largest and best equipped in the country, there are several others of possibly equal importance, notably the laboratory of the Massachusetts Institute of Technology. The ore-dressing laboratories here are arranged in a manner similar to those at Columbia and this institution has been a pioneer in the matter of industrial cooperation, although the plan devised is radically different from that at Columbia. Here the industrial concern signs a contract form of agreement, submits its problems and pays fees for the work done on them. A recent report indicates the plan has been very successful in the past year.

The important result is not to the school, however, for this is only the means to an end. The real results are first of all in enlarged opportunity to the student and finally a solution of a very difficult problem for the mining industry. The significant thing is that the industry is placing its faith in science for guidance through the difficult years ahead.

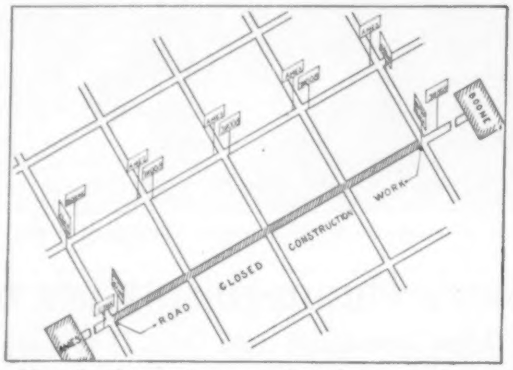
Mirror for the Motor Cop

FOOLHARDY indeed the motorist who ventures into our busy streets without the security of a mirror to protect him against reckless driving from behind. And now the traffic officer is supplied with similar protection, which serves equally to inform him of the state of traffic behind him without the necessity for his indulging in the merry-go-round act. The director of street intersections of Washington, D. C., ought to be much more easy in his mind, and much more efficient in his work, with this accessory.



The officer as well as the motorist sometimes needs eyes in the back of his head

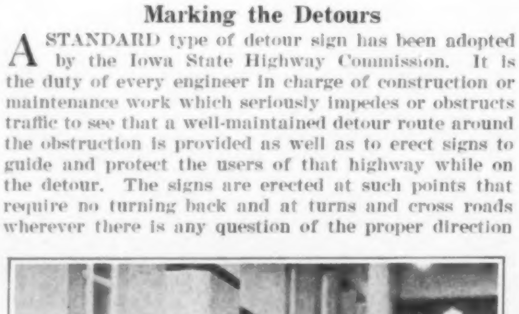
Iowa's universal standardized detour sign; the destination goes in the arrow in big letters



How the detour signs are planted so as to leave no room for doubt whether to turn or to bear straight

Marking the Detours

A STANDARD type of detour sign has been adopted by the Iowa State Highway Commission. It is the duty of every engineer in charge of construction or maintenance work which seriously impedes or obstructs traffic to see that a well-maintained detour route around the obstruction is provided as well as to erect signs to guide and protect the users of that highway while on the detour. The signs are erected at such points that require no turning back and at turns and cross roads wherever there is any question of the proper direction to be taken to pass safely around the obstruction without getting further out of the way than necessary.



The garage bumper that is always in the right place

The sign is in the form of a yellow arrow upon a black background. Above and below the arrow is the word "detour," so the sign may be used for directing travelers either direction by simply painting out with black paint the lower word. A stencil is used to paint in the arrow the name of the place the traveler is being directed to. In the case of the marked tourist roads, there is space on the arrow for the route marking in colors. In size the sign is 10 by 28 inches and is printed on tough paper. When displayed it is nailed to a board. The counties buy the signs at cost from the Commission and plus the expense of stenciling and place each sign costs about seven cents.

Ohio is another State that has largely abandoned the haphazard way of posting detours formerly in vogue. Its standardized sign is in all essentials the same thing as the Iowa product that we illustrate. It must be confessed, however, that Iowa has been more successful in placing the signs so that a minimum of ambiguity results. In Ohio an effort is often made to set the board at an angle to make it more readily spotted from an approaching car; but the result is more often to create doubt as to whether to bear straight ahead or to turn. Iowa, on the other hand, has a standardized style of locating the signs, as well as a standard sign; our little map makes it clear how this works. Other States approximate to this scheme, but largely, it appears, through accident; in Iowa it is prescribed and understood procedure, to the tourist's great comfort. Ohio, on the other hand, goes Iowa one better in the matter of economy. She does not paint out the lower word "detour," but leaves it in, since its presence leads to no slightest confusion. And she does not stencil in the destination, but pastes in a big paper label bearing the word. The sign may then be moved from detour to detour until it is naturally worn out.

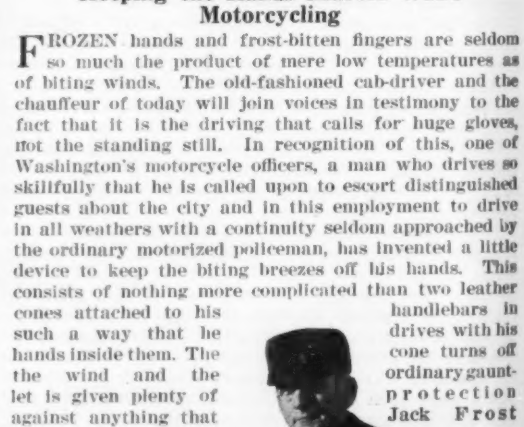
It is gratifying to the motorist to note the general improvement in the posting of detours. Five years ago nobody ever expected to have official guidance out of a detour. Today we are indignant if we do not get it; and in addition to the two States here named, and to Wisconsin, whose efforts have been described in a previous article, New Jersey and Pennsylvania may be placed on the roll of honor. New Jersey is even issuing a monthly bulletin, which the State Commissioner of Highways will mail to any address, giving full information as to roads closed and detours in effect for the month. New Jersey, incidentally, is doing a lot of work on her highways, without much advertising, and by the opening of the 1922 motoring season, assuming no undue amount of winter damage, she will rank high among the touring States. That this State is one of the most scenic of them all is a fact not as well known as it ought to be; and its attractions are within easy reach of millions of residents of New York, Philadelphia and even Baltimore, Washington and Boston.

Portable Bumpers for the Garage

GARAGE necessity often calls for the presence of a bumper; but the necessity is a difficult one to meet, because it is such a shifting one. Today the bumper is needed here, tomorrow there; next day a bumper in either of these places would be a terrible nuisance, but one is badly wanted at a point where it would have been distinctly out of place before. The portable concrete bumpers which we illustrate herewith are not too heavy to be shifted about with these shifting necessities; yet they are bulky enough to serve admirably the purpose for which they are designed. It will be noted that they have each two eyes, to which ropes or chains are attached for the purpose of dragging them from point to point as required.

Keeping the Hands Indoors While Motorcycling

FROZEN hands and frost-bitten fingers are seldom so much the product of mere low temperatures as of biting winds. The old-fashioned cab-driver and the chauffeur of today will join voices in testimony to the fact that it is the driving that calls for huge gloves, not the standing still. In recognition of this, one of Washington's motorcycle officers, a man who drives so skillfully that he is called upon to escort distinguished guests about the city and in this employment to drive in all weathers with a continuity seldom approached by the ordinary motorized policeman, has invented a little device to keep the biting breezes off his hands. This consists of nothing more complicated than two leather cones attached to his handlebars in such a way that he drives with his hands inside them. The cone turns off the wind and the ordinary gauntlet is given plenty of protection against anything that Jack Frost may produce in the way of temperature.



Protecting the motorcycle driver's hands from the wintry winds

The Service of the Chemist

A Department Devoted to Progress in the Field of Applied Chemistry

Conducted by H. E. HOWE, Chemical Engineer

Light in Water

TO emphasize the desirability of properly supporting fundamental research *Engineering Foundation* has been distributing "Research Narratives." A recent one on "Light in Water" by L. N. Scott is quoted below:

"It is natural to suppose that light penetrates clear water as it does glass. The Prince of Monaco, one of the greatest students of marine life, has shown, however, that there are myriads of animalcules in sea-water and that they cause almost total reflection of a beam of light projected into the water. Therefore, water is not like glass in its transmission of light.

"In connection with submarine detection studies, Mr. Elmer A. Sperry, member of the Naval Consulting Board, made some elaborate experiments on projecting light through water, from which instructive results were obtained. An electric light was used having a sixty-million-candle-power beam, which could be seen through air for 62 miles (150 amperes, 75 volts, condensed and directed by a 36-inch projector).

"This light was placed in the bottom of a steel well resembling a boiler 25 feet long, with an opening in its side near the bottom 40 inches in diameter, in which a plate-glass window one inch thick was sealed. There were several tons of lead in the bottom of the well so that it would sink vertically to any desired depth. It was hung by a bale from a crane on a large barge.

"The light was first tested in the muddy waters of the New York Navy Yard, at a depth of 10 or 15 feet below the surface. There was a total reflection of light, but this was attributed at that time to the great muddiness of the water. A luminescent sphere approximately 80 feet in diameter surrounded the window. This luminescence was wonderfully brilliant and acted like a fog to obscure vision. Brilliancy of luminescence seemed to be about the same at all points of the sphere, even exactly back of the well in the rear of the window through which the light was projected.

"Experiments were then made in clear ocean water near the easterly end of Long Island. Here also it was found that the beam of light could not be projected through the water as had been hoped, and that a globe of luminescence was produced as in the experiments in the New York Navy Yard. The globe of luminescence was visible through this comparatively clear water for possibly a quarter of a mile, and it could be used for the purpose of silhouetting mines, anchors, cables and other objects of this nature, against its white background with very great distinctness, up to this distance of a quarter of a mile.

"The results of these interesting experiments with so powerful a light are a real contribution to our knowledge of the art of projecting light through water. They indicate the impracticability, in most situations, of projecting light to any great depth into water in such a way as to be an aid to divers employed on ordinary under-water operations, or for other purposes."

Leather Nomenclature

THE terms used in defining the various leathers are not only little understood by the average user of leather but by the leather chemist as well, and the compilation of data given by Yocum and Faust in the May number of the *Journal of the American Leather Chemists' Association* will therefore be found helpful and valuable. There are eight designations for various types of sole leather, eleven for the cuts of sole leather, twelve for leathers used in automobile, carriage and upholstery work, five under belting, eight under harness and saddlery and similar numbers under such other headings as light leather of goat, calf, and sheep. Most of us purchase leathers under the designations given to finishes, and the following are taken at random from the definitions given under the heading of grain finishes:

"Box Calf—Boarded in four directions shape of square, so as to give heavy grain.

"Glazed Kid—Goatskins finished with high face by jack.

"Glove Grain—Black dull side upper leather, lightly buffed.

"Gun Metal—Smooth, dull black finish.

"Levant Grain—Usually bark tanned, carefully split, buffed, lightly embossed and grain well boarded.

"Patent—Varnish coat, either linseed or 'dope' (pyroxyline); several layers applied and dried by heat, process called Japanning. Used on bark-tanned leather for shoe trade.

"Russia Leather—Gambier tanned calf, very fine grain.

"Spanish Leather—Upholstery leather; whole hide grains or buffs bark tanned and finished dark yellow with irregular black figurations.

"Velour—Glazed, smooth-finished calf.

"Ooze—Run on emery wheel to give nappy surface.

"Suede—Surfaces made nappy by putting on emery wheel; similar to Ooze."

Malt Extract in Bleaching and Dyeing

THE above is the title of an interesting article in the May issue of the *Color Trade Journal*, and the following uses to which concentrated malt extract has been put in the textile and allied trades are quoted:

"(1) Stripping was the original purpose to which concentrated malt was applied. A good malt extract is completely soluble in lukewarm water, and is immediately ready for use. The solvent action is rapid and has no harmful effect on the fiber. The malt has no stripping action on fast dyes.

"(2) The preparation of sizes and mixings forming a starch paste penetrates evenly and does not dust, harden or contract. The excellent series of articles on standard finishes for cotton goods which appeared in *The Dyer* a few years back seem to point out that concentrated malt had become an indispensable ingredient in almost all finishing mixings.

"(3) In the preparation of printing pastes the same advantage of easy penetration of the printing color is obtained. It gives a smooth, even paste and the thickening is readily removed on steaming.

"(4) Softening light leathers before dyeing.

"(5) Removing starch from old rags in the paper-mill or for the preparation of gun-cotton.

"(6) Preparing coating mixings for paper. The calender gives the best gloss where malt extract is used.

"(7) Clearing dressing from linen previous to adding the 'dope' for aeroplane wings.

"(8) Dextrinizing starch for linen dressing in the laundry, or as 'new work.'

"This list does not pretend to be exhaustive. As the trade progresses, malt extract will go hand in hand with starch in all its multifarious uses."

The Bearing of a Synthetic Dye Industry Upon Our National Welfare

IN the April number of the *Franklin Institute*, an interesting address upon this subject is given and is recommended to those who desire to be informed upon this very important question. What the loss of the industry would mean to the country is set forth under ten headings which we give here:

"1. Thousands of unskilled laborers thrown out of employment.

"2. Large numbers of specially trained technical experts forced to seek other means of livelihood, and the economic loss involved in scrapping the experience gained in the dye industry.

"3. Abandonment by the manufacturers of all plans for development and expansion, and the closing of plants now in operation.

"4. Fewer students for the courses in chemistry at our educational institutions.

"5. Termination or reduction research work, both in the laboratories of the industry and in cooperative investigations with educational institutions, with all that this implies in retardation of the development of our science at a time when the world is looking to us to take the leadership.

"6. Inability of teachers of applied organic chemistry to give their students up-to-date information in the field of synthetic dyes, through loss of personal contact with the manufacturer, and an inevitable resulting dependence upon the ancient history of the average textbook of industrial chemistry.

"7. Subjugation of our great textile industry, and of other industries using dyes or dye intermediates, by foreign manufacturers, and in the event of our being cut off from such supplies by another war, once again to be face to face with a famine, not only in the dyes needed for our flags, uniforms, and other articles, and the bacteriological stains for the diagnosis of disease, but in many indispensable drugs and in compounds of serious concern to the manufacturers of photographic chemicals, food preservatives, explosives, toxic gases and other war munitions, paints, inks, perfumes and flavoring principles, artificial resins, plastics, tannics, and accelerators for rubber vulcanization. The distilling of coal tar and the recovery of by-products from the coking of coal will also suffer from the loss of this market for their products.

"8. Should we be one of the belligerents, there will be but few dye plants available for conversion to munition manufacturing (be it explosives, toxic gases, smokes, incendiaries, or what not), and no reserve of trained men to take charge of such operations. It is trite, but true, that modern military power is dependent upon industrial organization and efficiency.

"9. Domination of our trade in dyes and dye intermediates, by Germany, for example, is quite certain to lead to the control of others of our industries as well, until the penetration of our industrial fiber will resemble that of the chestnut tree by the deadly fungus which has so nearly obliterated these beautiful trees from our groves.

"10. The world markets open to other nations will be inaccessible to us."

Fungi on Frozen Meat

SPECIAL Report No. 6, of the Food Investigation Board of Great Britain has been issued in which the black spot and other types of fungi found on chilled and frozen meat are discussed. Black spots on the surface of beef and mutton brought from the Argentine and New Zealand and some other countries are commonly found upon arrival, and such meat is liable to be condemned at the port of entry. Investigation has shown that these spots are due to fungi or molds which develop when meat is stored for unduly long periods in the producing countries. The color is due to the fungus threads which permeate the superficial layers of the meat. Frequently these spots are so numerous as to overlap one another, and if too prevalent the meat is very unsightly and unsalable. The spores are carried in dried herbage or fodder which the animals are liable to be fed before slaughter, and meat may become contaminated either just before being placed in storage or while actually in storage. If during the storage the temperature rises above the freezing point or if the meat is removed from storage the spots form spores freely on the surface of the meat, but apparently no spores are formed at temperatures below freezing. Experiments have been conducted to determine under what conditions the black spot would develop in cold storage.

In artificial media the fungus develops quickly, at temperatures from 18 to 22° F., and if early stages of germination are effected before subjection to low temperature, it is found that subsequent development in storage is more rapid and, with meat, more certain. Even in cases where spores were kept at from 18 to 22° F. without germination for a period of six months, they develop normally when removed to ordinary temperatures. It is believed that fluctuations of temperature even when below the freezing temperature would increase the danger of the development of black spot on account of changes in humidity and particularly if snow is deposited, this tending to collect spores present in the air and deposit them upon the surface of the meat. The fungus, however, does not produce toxic substances during growth so that the presence of the fungus alone does not render the meat dangerous or unfit for food. Indeed, the investigators have eaten large quantities of fungi mixed with other food without deleterious results. However, meat which has been in storage so long a time as to develop numerous spots of this character may easily have become unfit for food due to entire different causes. Thus black spot may be accompanied by putrefactive bacteria.

Other fungi which may or may not accompany black spot are now under investigation and subsequent reports will deal with the exact condition under which these various forms develop upon meat.

The Heavens in November, 1921

Some Details of the Great Telescopes of the Western Observatories

By Prof. Henry Norris Russell, Ph.D.

A COUPLE of months ago we had occasion to speak of the situations and surroundings of some of the great observatories. It may be of interest to supplement this by some impressions gained while watching, or sharing in, observations with some of the greatest telescopes.

The astronomical telescope, if of more than a very moderate size, depends for its utility almost equally upon the perfection of its optical and its mechanical parts. The importance of the former is known to everyone who possesses any astronomical knowledge. No mechanical refinements can avail if the lenses or mirrors which bring the light to a focus deviate from their appointed duty of bringing all the light which falls upon them into an image which is substantially as sharp as the laws of optics permit. It is widely known, too, how long and painstaking a task it is to "figure" a large mirror or, even more, a great lens. Months or years of labor go into the final polishing which brings the two surfaces to exactly the desired shape, and repeated, careful tests, time after time, must be made before the necessary precision can be realized.

But good optical parts, however perfect, are of but small usefulness unless they are carried by an accurate, strong, stable and well-functioning mounting; and this mechanical precision becomes, decade by decade, of more importance. Half a century ago, when almost all observations were made visually, work could be done, though at a sacrifice of convenience, with a telescope that lacked rigidity, so that a slight lateral pressure on the eye-end swung the image perceptibly in the field of view, or with a poor driving clock, which did not follow the stars exactly, but allowed the images to drift gradually through the field, or to oscillate slowly backward and forward within it. But in our days, by far the greater part of the work of the largest telescopes is done by photography—whether by making direct negatives of larger or smaller regions of the heavens, or in the study of the spectra of the stars; and in such work it is of fundamental importance to have accurate "guiding." If the image of the star wanders off the slit of the spectroscope, its light no longer enters this instrument, and the whole use of the equipment is lost until the image is brought back to its rightful place. In direct photography, especially when the plates are to be measured for determination of the positions of the stars, bad guiding is still worse. If the light of the stars falls to one side of the proper position for even a small fraction of the whole length of the exposure, the star images on the plate will not be small and round, as they ought to be, but deformed and irregular; and the effects of this distortion upon the position of the center of the image will be different for large and for small images. Such a plate will indicate a spurious shift of the brighter stars, compared with the fainter ones, and for any purpose that demands precision will be worse than useless.

One further requirement is essential. The observer must be able to get to the part of the telescope where the light is brought to a focus, and he must be able to stay there while the instrument turns to follow the stars. With a large instrument and a long exposure this may involve horizontal and vertical displacements of many feet, and some appropriate movable carriage or platform must be devised to permit of this.

How the Big Tubes Are Mounted

The great refractor of the Lick Observatory—which has now been in active and most successful service for a generation—is a fine example of the older methods of solving these problems. The optical parts are of course of high excellence, as is the case with all other great telescopes, which have necessarily passed the strenuous tests that are imposed by their makers. The mounting is of the familiar equatorial type, with the long straight tube, on one side of the center, balanced by a counterpoise at the opposite end of the declination axis.

The observer looks directly toward the object of his study, as is usual with small instruments, and he may have to move twenty feet horizontally, and fifteen vertically, during a long spell of work on a single star. The vertical motion is taken up by that very convenient device, a rising floor, which is moved by hydraulic machinery, and can be quickly set at any desired level. An observing chair, of the ordinary type and of moderate size, can be wheeled over the floor as desired, and in addition permits a few feet of vertical motion of the observer's seat. This completes the equipment.

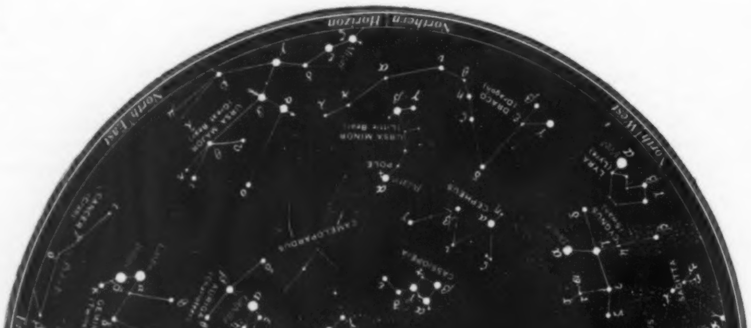
The great reflectors produce a very different impression. To begin with, the "tube" is not completely enclosed, as with the ordinary instruments, but is of skeleton structure. The principal focus of the mirror is of course at the upper end of this tube high in the air. Small spectroscopes or plate-holders may be placed at this focus, supported in the center of the tube; but it is more usual to reflect the light again by a mirror placed near the upper end, either at right angles to the side of the tube at the top (the Newtonian form), or back down the tube and through a hole in the center of the great mirror (the Cassegrain form). The great reflectors are equipped in both these ways, the change from one mounting to the other being effected by substituting one or another "cage" or section of the skeleton tube at the upper end—each carrying its own mirrors, etc., and fitting exactly into place.

To carry the great mirrors, which themselves weigh tons, the mountings of such telescopes must be exceedingly massive; their design is in fact an engineering problem, something like the one involved in the building of a steel bridge. To bear the weight safely is the least of the requirements. The flexure, or bending of the tube, under these weights must be so small that it does no harm, and the instrument must be exactly balanced in all positions, its bearings so perfect that a force of a few pounds can set and maintain in motion the many tons of moving parts. Moreover, all these delicate adjustments must remain correct when the telescope is pointed at any part of the visible heavens.

More than one solution of these problems is possible—indeed, the mountings of the three largest reflectors are all different. In the 60-inch at Mount Wilson the upper end of the polar axis projects in an enormous fork, within which the tube is mounted on trunnions, the point of support being close to the lower end, since the heavy mirror far outweighs the relatively light ironwork of the opposite end. This construction leaves the telescope free to point at the pole, or at any other part of the sky.

The 72-inch telescope of the Dominion Observatory at Victoria exhibits a different solution—a short, stout polar axis supported by piles at each end, pierced by a declination axis carrying the telescope on one side and a massive counterpoise on the other, so that the whole effect is much more comprehensible to the novice.

The 100-inch reflector at Mount Wilson is of such enormous size—the moving parts weigh about a hundred tons—that still another mounting was adopted. The great tube swings between two gigantic steel beams, which are united at their upper and lower ends and together form the polar axis. They are supported by massive piers at their upper and lower ends. As with the 60-inch, a large part of the weight is taken off the bearings by means of a cylindrical hollow iron float, which is partly immersed in a tank containing mercury. The space between the float and the walls of the tank is narrow, so that the quantity of mercury actually used is but a small fraction of that which is "displaced" by the immersed portion of the float, and thereby effective in producing buoyancy. With this mounting it is impossible to look directly at the pole; but this sacrifice, though serious, was judged to be worth while, in view of the great engineering difficulties of carrying so great a weight without support at both ends of the main axis.



At 11 o'clock: Nov. 7.
At 10½ o'clock: Nov. 14.
At 10 o'clock: Nov. 22.

At 9 o'clock: Dec. 7.
At 8½ o'clock: Dec. 15.
At 8 o'clock: Dec. 23.

At 9½ o'clock: November 30.

NIGHT SKY: NOVEMBER AND DECEMBER

Where the Observer Comes In

All these telescopes are provided with a very elaborate system of electrical controls. By simply pressing one of a set of buttons, the observer can move the telescope as he wishes, east or west, north or south, fast or slowly, and can also adjust the focus, and turn the dome; while an assistant at a control desk can with equal ease direct the larger movements which are necessary in shifting from one star to another. Another set of push buttons controls the motions of the observing platform. For the 100-inch telescope there are two of these. The one used when working at the Newtonian focus is attached to the dome, suspended from a curving track on each side of the observing slit, and can be moved up or down at will. It is a roomy affair, holding half a dozen visitors. At the Cassegrain focus, in this instrument the light is brought out to the side of the tube, a few feet above the mirror. Hence there is less space to spare, and the observer's platform is a narrow shelf six or seven feet long and three feet wide, with only a railing an inch or two high around the edge. On this platform the observer sits, with his feet hanging over into space.

As an example, suppose that star-spectra are being photographed. The observer looks into an eye-piece, and sees the outer surface of the slit-plate of the spectroscope, illuminated by a faint red light. This surface is highly polished and reflects the image of the star under observation. Across it runs the narrow dark line of the slit itself, but a few thousandths of an inch wide, into which the light of the star should go. Minute alterations in the running of the driving clock, or in atmospheric refraction, cause the image to shift its position, and the observer must therefore keep watch and bring it back to the right place. So perfect is the mechanism that after a few minutes' practice it is possible to bring the image to any desired point, within less than 1/500 inch on the slit-plate. The corresponding motion of the main mass of the telescope is only about a tenth part as great, yet this minute motion of the huge mass can be made with certainty!

The planetary and lunar details for the month are given on another page.

When More Voltage Means More Distance

The Limits of Long-Distance Electric Power Transmission in Terms of Today and Tomorrow

By Dr. Charles P. Steinmetz

Chief Consulting Engineer, General Electric Company

WHEN about 40 years ago, Edison first transmitted electricity at constant pressure, that is, constant voltage, he used 110 volts and soon afterward 220 volts. At this electrical pressure or voltage, electricity can be sent economically for about half a mile to a mile, and when it becomes desired to send electric power over longer distances, higher voltages, that is, higher electrical pressures, become necessary, just as a higher water pressure or higher air pressure is necessary to send water or air over a greater distance.

Thus steadily in these 40 years, transmission voltages have been increased, until now we are beginning to use 220,000 volts, a pressure just 1000 times as high as that considered the highest safe pressure only 40 years ago.

The question, which the layman always asks, is, "How far can electricity be transmitted economically?"

Suppose we want to double the distance to which to send the electric power. This means twice as long a transmission line, and twice the cost. Therefore, to have the same economy, that is, the same transmission line cost per horsepower of electric energy sent over it, we have to send twice as much power over the line of twice the length. Suppose then we use the same electric current but twice the voltage to get twice the power. With the same current, the loss of power per mile of line would be the same, and as the line is now twice as long, the total loss of power would be doubled, and as twice as much power is sent over the line, the loss per horsepower of energy sent over the line is the same, that is, the efficiency of transmission is the same as before.

We see thus, that by increasing the voltage or electric pressure, and the power sent over an electric transmission line, in proportion to the distance of transmission, that is, to the length of the line, we get the same efficiency and the same economy, that is, the same percentage loss of the transmitted power, and the same (approximate) cost per horsepower transmitted.

If then at 220 volts electricity could be transmitted economically over one-half to one mile, at a thousand times that voltage, or 220,000 volts, as now used, it could be transmitted economically over a thousand times the distance, that is, 500 to 1000 miles, and if 100 horsepower could be transmitted at 220 volts we would have to transmit 100,000 horsepower at 220,000 volts.

As for 100,000 horsepower the generating system, etc., is cheaper per horsepower, and more efficient, than for 100 horsepower, we could in the former case allow a greater cost and greater loss per horsepower in the line, and still get the same total efficiency and economy of the system, and this would allow us to economically transmit the electric power over more than 1000 miles' distance.

Hereby all the big cities of the Atlantic seaboard and of the Middle West, New York, Boston, Philadelphia, Baltimore, Washington, Chicago, St. Louis, Pittsburgh, would be well within the radius of economical power transmission from Niagara Falls, with the present means and methods, that is, without going beyond what present experience has established as good practice.

It is not probable however that electric power would ever be sent from Niagara Falls to New York or any other of these cities, for the simple reason that in the industrial East all the millions of horsepower of electric energy which Niagara could deliver, even if completely developed, would find a market and would be consumed within a few hundred miles of Niagara, long before the present day electrical limits of transmission are reached, and obviously nobody would build transmission lines to send the power over thousands of miles, when he could find a market for his power within a few hundred miles.

The question of the maximum distance over which electric power can be transmitted, therefore, has almost entirely eliminated itself as a serious engineering problem, and while electricity could be transmitted economically in large bulk, if so desired, for over a thousand miles, even with the largest water powers, with rare exception, all the available water power will be taken up, and find a market, long before the electrical limits of transmission are reached.

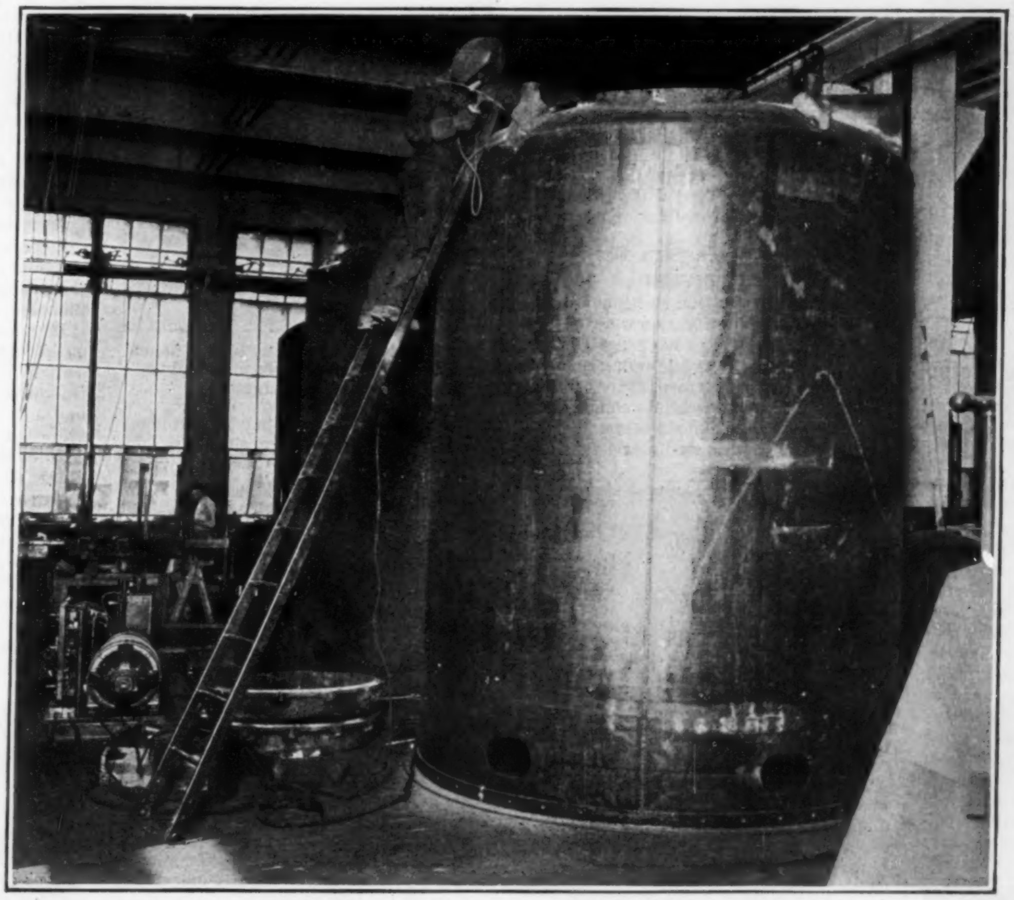
One of these exceptions is the Pacific Coast. There the water powers are located inland, in the mountains, while the foremost market for the power is in the big cities along the seacoast. The transmission thus is all in one direction, from the east to the west, and little market for the power is near the source of power, little power found near the places of foremost power consumption.

It is a very significant and well-demonstrated fact that the highest transmission voltages, 150,000 to 220,000 volts, are found in California.

Another instance might be the transmission of the power of Victoria Falls in South Africa to the Rand, over 700 miles. However, it is quite possible that before this transmission is built, the country will have developed so far as to afford a market nearer than the Rand, and the experience of Niagara Falls will repeat itself.

Thus today there is very little electrical power transmission of the form as understood in the early days and as the layman looks at it still today, that is, a transmission from a water power over a long line to a consumer, such as a city, etc.

But our present day transmission lines are almost always distribution circuits and interconnecting circuits, that is to say they form a part of a network of electric lines, which link together various sources of electric power, water powers and steam powers, and the various places of consumption, cities, mines, factories and mills, and so forth. That is, a network of electric lines begins to cover the country similar to the network of railway tracks, and while the network of railway tracks, built three-quarters of a century ago, takes care of the transportation, distribution and supply of all the materials, so now a network of electric lines is being developed and is spreading all over the country of so adequate a volume as to take care of the transmission, the distribution and the supply as the second essential necessity of our civilization.



Welding the tanks for 220,000-volt oil circuit breaker now being constructed for 220,000-volt transmission line in Southern California

A New Carburetor for Light Oils

A NEW apparatus invented by a Frenchman, M. de Maumy, makes it possible to operate a motor by means of coal-tar oils or alcohol or a mixture of the two. Its principle consists in a feed operating by an automatic gage so as to maintain a constant charge of the atomizers without any previous heating of the liquid. The atomizer works by a lapping or licking motion lowering the pressure in the cylinder during the intake, causing a flow of air which laps a cylinder with an undulating surface; the oil is sucked in violently, being atomized by shocks and thus enters the cylinder. The intake of air should be somewhat retarded, and this retardation is obtained by a modification of the cams of admission. The mixture is ignited by an ordinary motor spark plug and it begins to work instantaneously either with alcohol, kith kerosene, or with coal-tar oils. Upon being tested the apparatus worked admirably. It is very simple in construction, requiring neither a pump nor any sort of heating apparatus.

There is no carbonization of the cylinders even when coal-tar oils are used for fuel, and the negligible amount of smoke given off shows that the combustion is excellent. This apparatus, which is capable of functioning at a low compression can be applied without difficulty to nearly all gasoline motors.

It has the considerable advantages over Diesel and semi-Diesel motors of being less complicated, less cumbrous, and quite safe; moreover, the upkeep costs nothing.

At the same time it is possible to make use of inferior and lower priced fuel with an efficiency almost as economical in high speed motors as well as in slower ones without making it necessary to purchase a special high compression motor, which would inevitably add considerably to the weight, to say nothing of the high price, the difficulty of transport and other features that need not be mentioned but which have to be considered.

These entirely new processes denote a marked advance in the solution of the problem involved in the substitution of crude oils and of alcohol for gasoline, so that they will undoubtedly rapidly come into general use.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

This device automatically handles vehicular traffic at important street intersections

A German Version of the Motor Wheel

SOME ingenious German inventor has taken our American motor wheel, which fastens alongside the rear wheel of any bicycle, and made it over into something that is sufficiently different to possess several talking points in its favor. As will be noted in the accompanying illustration, this German motor wheel is carried at the rear of the bicycle by means of a long arm. It would appear that such a motor wheel can be readily attached to any bicycle, and that because of its distance away from the cyclist there is no danger of dirt or smoke or smell. Just what complications such a pushing device may introduce in steering, we are not told. At any rate, the motor wheel is said to push any bicycle over 30 miles with one gallon of gasoline, which is not as efficient as some of our American types.

The folding wheelbarrow, in use and folded up for putting it away during idle moments

The Automatic Traffic Policeman

THE automatic traffic policeman, a quite recent invention, is placed at street intersections, in the position usually occupied by the human traffic officer. The semaphore of this device is constantly illuminated; it says "GO" for a predetermined number of seconds, then the light at the top of the machine comes on for an instant. This corresponds to the policeman's whistle, and means "Hurry across, or wait." The semaphore then turns to the next position which gives "STOP" to the street which previously had "GO," and so on.

The automatic policeman is adjustable as to intervals and hence can meet the requirements of any given corner, reducing to a minimum the amount of time people might be needlessly held up. For example, it may be set to take one minute for a complete revolution of the semaphore, divided equally or unequally, or it may be set to revolve in 30 or 40 seconds, divided equally or otherwise between "GO" and "STOP."

While it is new to the market, it embodies only proven mechanical principles —an electric motor and a Geneva cross movement being the two major parts.

Another Attachment for the Phonograph

THE latest invention destined to improve and amplify the tone of the usual phonograph is a little device that is attached on the usual sound box. It depends for its performance upon a vibrating disk of special composition which, so it is claimed, takes up the vibrations from the needle and tends to

German motor wheel which fastens on behind a bicycle by means of a long arm

amplify and clarify them, before they are transmitted to the sound box diaphragm.

A Folding Wheelbarrow

FROM France comes the idea shown in the accompanying illustration, namely, a folding wheelbarrow. The French inventor explains that there is need for a folding wheelbarrow, especially in winter time when it can be folded up and taken into the house, there to be stored in a closet or some other out-of-the-way place. At any rate, the construction is neat and quite practical, we gather from the two photographs.

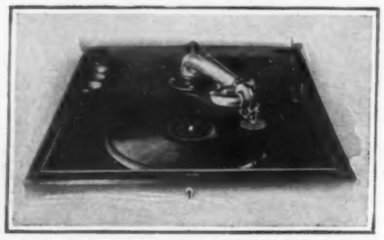
A Wireless Meter for Testing Starting Systems

THE little meter, which is shown in the accompanying illustration, has been designed for the purpose of locating ignition, starting and lighting troubles in the usual automobile. There are no wires to disconnect, there are no wires to connect. Indeed, this instrument is truly a wireless type. The operation is simple —just place it on the wire to be tested and the meter indicates the amount of current, if any, flowing through the wire.

This little meter consists of a main instrument having a 30-ampere divided scale. That is, the scale may be read either way, depending on whether the wire is the positive or negative wire. The instrument is fitted with a 300-ampere magnetic shunt, which is a steel ring that fits around the meter casing. This shunt is used when testing high ampere current ranging from 30 to 300 amperes, and is principally used for starter work, while the 30-ampere scale is used in lighting, ignition and, in fact, for all circuits of relatively small current flow.

An Improvement in Oil Cups

BY making use of a small steel ball which is pressed down by spring against the opening of the stem so as to regulate the distribution of oil, a newly-introduced lubricating device is claimed to represent a marked economy in lubricating oil consumption. In fact, this new oil cup is said to save from 40 to 60 per cent in oil consumption on various kinds of machinery on which it has been employed. It places the oil in such sufficient quantity as needed for proper lubrication and eliminates all waste, therefore doing away with drip pans and making for clean walls and ceilings in the shop and factory. By the same token it lengthens the life of belting, since it prevents oil from coming in contact with the belts.



The little disk attached to the usual sound box is said to improve phonographic reproduction

The ball lubricator cups are automatic in operation, feeding the oil when the machinery is running and stopping the feed when the machinery is at rest. This eliminates the danger of burning out bearings through failure to turn on the oil when machinery is in use, or through failure to shut off the flow at night when the day's work is done, thus allowing the oil to run out of the cup and on to the belting and floor. The ball cups require a minimum of refilling.

A Thief-Proof Alarm for the Automobile

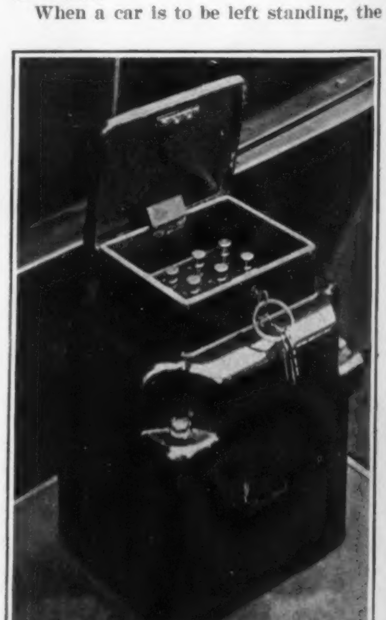
THE prevention of automobile theft now takes a new turn. Instead of applying all manner of locks, ignition safeguards, chains, tire rings and free steering wheels that cannot steer, there has been developed an alarm which, when mounted on any automobile, advertises the fact to everyone when the automobile is being tampered with by an unauthorized person.

This new device is a well-protected, self-contained alarm which is placed on the running board of any car, and is always visible. The alarm is contained in a heavy aluminum case which is bolted or riveted to the running board in such a manner that its removal requires considerable time, during which the alarm must sound. There is nothing intricate or complicated about the device, but it is fully protected and cannot be silenced by application of high-voltage current, or in any manner, except by spending an hour dissembling it. A special large gong bell is installed inside the case, and draws approximately ½ ampere. The current is supplied by three standard dry cells, mounted within the case.

The simple type of ammeter which indicates current flowing through wires, without connecting it

It appears that this device makes use of a floating, compensating mercury switch which gives instant and continuous contact under lateral vibration, and no contact under vertical or road vibration. The switch is thrown into contact by a 12-key push-button combination switch, which, so it is claimed, gives over 1,000,000 combinations. To ensure against tampering, the upper and lower halves of the case are made a circuit, so insulated apart that until the case is sprung or tampered with the circuit is open. Any attempt to force the case will close the circuit and cause an alarm.

When a car is to be left standing, the



Automobile theft alarm with cover open to show the push-button combination switchboard

This little device, when held up to the light, gives a definite exposure for the photograph

top of the device is opened and the proper keys depressed to set the alarm. If anyone raises the hood of the car, steps on the running board, tampers with spare tires or otherwise touches the car, the sensitive mercury switch closes the circuit and the bell rings continuously until the owner of the car resets the device.

Correct Photographic Exposure at a Glance

AN ingenious little device which measures light in a manner analagous to the way in which a scale weighs a substance, has been invented by a San Francisco man. It will be of inestimable value to photographers, both amateur and professional, for it is a well-known fact that photographic value is often far different than the apparent brightness of the light.

The device must not be confused with so-called "exposure meters." It has no settings to make, no calculations to figure out, and nothing to look through. It is self-acting and requires no factors or tables in its manipulation. Instead, it is simply pointed at the source of illumination—sun, window, or whatever it may be—and the intensity of the light is instantly shown. A corresponding dial indicates relative exposures and stop-settings for the camera for that particular light.

The little light meter is about the size of a silver dollar and as it requires no adjustments or settings, its value to the "kodaker" or to the professional photographer is apparent, for it does away with the dread "trick light" miscalculation which every photographer knows too well.

From Coffee Container to Galvanized Egg Cartons

A HOOSIER wholesale grocer packs coffee in a new way—one which is very attractive to the retailer as well as to the freight agent who handles it.

The coffee cartons, one pound packages, are placed in galvanized containers and sealed. These containers have a lid and a bale for handle, admirably protecting the contents against damage in handling. When their use as coffee containers is finished the farmer can then use them for his egg crates, as the wholesaler has obligingly inclosed the little pasteboard separators. These egg crates have a capacity of twelve pounds and cost the farmer approximately $4.80. The egg crate alone would cost him $1.50; so he gets a first class grade of coffee at only about 27½ cents. This makes it a very attractive proposition to him, as he can find a thousand and one uses for galvanized crates besides the one above mentioned.

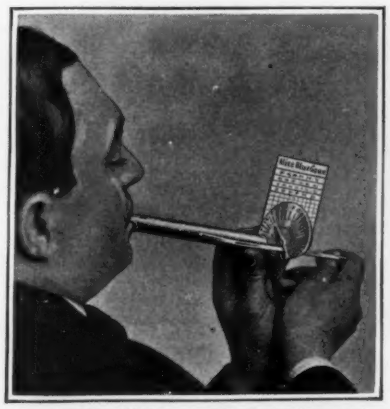
A coffee dealer packs his cartons in iron containers, which can be afterwards used for other purposes

Something New and Better in Folding Tables

FROM France comes the idea for a folding table which is shown in the accompanying illustration. This table, it will be noted, has telescopic wooden legs of much the same design as the usual camera tripod legs. The object of this construction is so that the table can be levelled anywhere, no matter how irregular may be the ground on which it is placed. The table is primarily intended for picnics, although it may be used for playing cards, making maps, as a desk for military men in the field, as a serving table, and for all purposes where a strong but portable table is desired. A small compartment in the table top holds playing cards, paper, writing materials or other things.

A Self-Teaching Musical Instrument

A NEW YORK inventor has developed a simple musical instrument which may be played by anyone without previous experience. The principle of operation is simple enough. A musical score is furnished in the form of a little card which contains a succession of letters. These letters correspond to the letters of a scale in front of which swings an indicator. The player brings the indicator in line with the first letter indicated by the card, and blows into the mouthpiece, and then sets the indicator to the second letter, blows again, and so on. Moving the indicator causes a piston to be shifted in the cylinder of the cylinder, thus changing the pitch.



A simple little musical instrument which enables anyone to play popular airs

Tractor Operated Cotton Picker

ONE of the seasonable occupations in the cotton belt is cotton picking and while this has been done by human labor for many years, new machinery has been developed that makes cotton picking a simple, mechanical operation.

A concern in St. Louis, Mo., which controls the Thurman patents is building a picker than can be utilized with any tractor, and claim is made that with six men it will do the work of thirty-six hand pickers and do the work 25 per cent cleaner. Very great economy is claimed on the basis of a capacity of 3,600 pounds of cotton a day for the machine and six pickers as compared with the average of about 100 pounds a day for good hand pickers. The vacuum picker consists essentially of a large metallic storage tank mounted on two wheels which is coupled to and is transported by a farm tractor which furnishes the power to drive a specially designed vacuum pump. When the pump is in service it is driven by a chain belt from a pulley. The chain may be driven by the same drive shaft that is used for belt power and engaged or disengaged as conditions may require.

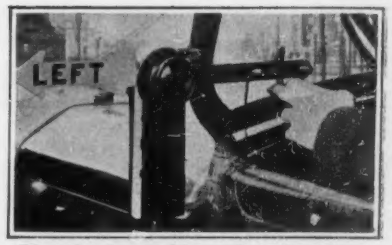
Simple folding table intended for automobilists, campers and soldiers in the field

The pump exhausts the air from the tank, which is tightly closed. In an upper compartment of the tank are six inlets to which are attached lines of hose, that have one inch diameter at the nozzles and increase to 1½ inches diameter at the inlets. At the end of each tube is a "Y" on the arms of which are intakes, there being twelve of these in all.

The nose is supported by the waist belts of the pickers, who hold a nozzle in either hand. The opening and closing of the nozzles are controlled by levers, operated by the fingers. When a nozzle is applied to a boll the cotton is drawn from it by the suction and drawn through the tube into the tank. The tank has a capacity of about 400 pounds of cotton and when filled it must be emptied. The tank is quickly discharged by dropping a circular trap or door at the rear of the tank and placing a cloth sack about the opening. The exhaust from the pump is turned into the tank and the cotton is blown from it into the sack, which is then tied and piled or hauled from the field. The maker claims that when the tank is full this fact is registered.

The truck that carries the tank is substantially built, a frame in which the tank is mounted being carried on an axle and two wheels. The tank is 66 inches long and 42 inches diameter. The frame has a drawhead and this may be coupled to the drawbar of the tractor.

The tank is steel and it is surrounded by a wire rack for carrying the hose when not in use or the picker is being transported. In the upper compartment of the tank is a gage that registers the degree of vacuum. In this compartment, above the intakes, is a screen that prevents the cotton being drawn into the vacuum pumps. The vacuum pump or blower is supported by two brackets bolted to the differential housing of the rear axle of the tractor, when this is possible or on some other unit where it may be driven by the belt pulley shaft, a small chain sprocket being substituted for the pulley.



The simple pushing of a tiny lever swings out the desired arm for warning the driver behind

Posting the Driver Behind

THE latest addition to our already large collection of published inventions of the automobile signal class, is presented in the accompanying illustration. It consists of an arm and a case containing a collection of arrow-shaped arms which read "Stop," "Left" and "Right," a red light which flashes red and illuminates the arm at night, and a collection of controls located within convenient reach of the driver. The driver, by means of this device, can swing out any desired arm so as to keep the drivers behind him posted as to his next move.

Automatically Closing Fire Doors

DESPITE the proven worth of the automatically closing fire doors, it is surprising to note the marked absence of such safety devices in many plants where they would undoubtedly give a great measure of protection in the event of fire. These doors permit of free access to and from all parts of a factory during normal times, but automatically swing closed at the first signs of fire. They are quite effective in preventing the spread of fire from one part of a building to another, as indicated by severe tests and in actual fires.

Two Drums in One

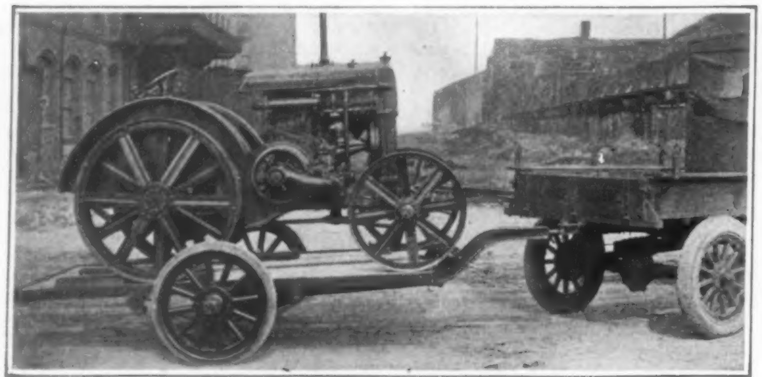
AN empty drum—and that means the usual drum—wastes a great deal of space. Why not put the various drum sticks and other paraphernalia inside the usual large drum? That is what occurred to a Brooklyn inventor, who has worked out a drum which can be used for carrying a smaller drum and all the paraphernalia necessary. By merely unlatching and swinging open a section of the large drum, various articles may be placed inside for the sake of greater portability.

This large drum may be opened so as to place a smaller drum within it for greater portability

A Trailer to Carry the Tractor

THE practice of carting tractors throughout the farming regions of California for demonstration purposes is becoming very popular with a number of dealers in that State. One can now buy a low-bed trailer, capable of carrying these tractors over the highways while being towed by a passenger car or a light delivery truck. This effects a great saving over the former method of using a special truck.

This trailer is equipped with a bed which can be tipped so that the rear end rests on the ground. The tractor is then run on to the bed by its own power, and the bed automatically tips to the carrying position shown and is locked in this position by a spring catch. When it is desired to unload the tractor, the operator lifts up on a handle which releases the bed and permits it to tip, when the tractor can be run onto the ground.—*By C. W. Geiger.*



Carrying the tractor to the job on a trailer is often more economical and convenient than driving it under its own power

A New Multiplication Machine

A NEW machine, called the "multi," has just been added to the list of computing devices in current French use. It gives quickly the product of any multiplication. As can be seen by our photographs, it is remarkable for its simplicity and its compactness. It comprises neither springs, gears nor other complicated parts.

The "multi" comprises a frame on the upper part of which seven axes can turn. Each of these supports multiplication tables wound on parallel cylinders disposed in such a way that only one of their columns appears at a time in front of the operator. The units in each column are separated from the corresponding tens columns which are carried over to the left against the units of the next set of numbers.

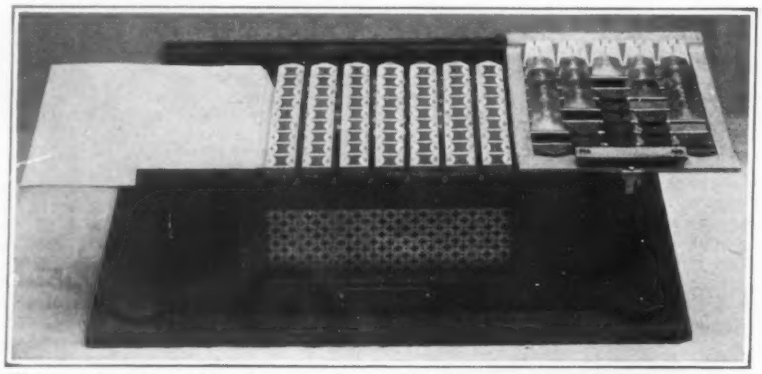
The putting together of these tables or of a part of these tables forms the multiplicand which appears in its normal order on the first line of these columns, in figures with a red circle around them. The multiplier appears on a moving carriage on sliding bars, containing nine rows of five "windows" numbered vertically from 1 to 9. By opening some of these "window-blinds," which are of equal size to the columns of the multiplicand, the multiplier is formed.

The inscription of the figures of the latter on the carriage is made in reverse direction to the multiplicand; in other words, the units are on the left, the tens on the right of the units, the hundreds on the right of the tens, and so on and so forth. The zeros are written by leaving shut all the blinds on the corresponding columns.

The various wheels of the "multi" reproduce mechanically the elementary operations of which an ordinary multiplication is composed. First, it is necessary to make a series of multiplications of a single digit by a single digit, the quantity of these multiplications equalling the product of the number of digits of the multiplicand by the number of digits of the multiplier; then the addition of these partial results follows; and finally the inscription of the result obtained.

To make these successive operations with the new machine, the adding-multiplying carriage is slid over to the right up to the tabulating stop. The multiplicand is then formed by revolving each axis so as to bring the necessary figures in front of the operator. If the number is composed of only three or four figures, the other figures are concealed by means of a blank, in order to avoid the unused columns appearing as zeros. The blinds necessary for making up the number of the multiplier are then opened on the adding-multiplying carriage, care being taken to remember that this number must be made up from right to left. Thus, 456 would be written 654.

Consequently, the first vertical row from the left side represents the units on the multiplying carriage; the second row from the left, the tens; the third row, the hundreds, etc., etc.



The new French multiplying machine, which gives quickly the product of any multiplication. It contains no springs, gears or other complicated parts

Once the factors are thus composed, the multiplying-adding carriage is displaced from right to left up to the second tabulating stop. The units column of the multiplier then places itself at the left half of the units column of the multiplicand (the tens of this column) and at the right half of the tens column of the multiplicand (units of this column). In the units window of the multiplicator, two numbers can be read (which may both be equal to zero). The first is the number of the tens of the partial product of the units of the multiplicator by the units of the multiplicand. The second is the number of the units of the partial product of the units of the multiplicator by the tens of the multiplicand. The operator notes them.

At the same time he brings the column of the tens of the carriage in superposition with the column of the units of the multiplicand. He reads through the window of this column a number which is that of the units of the product of the tens of the multiplicator by the units of the multiplicand. The total of the three numbers which appear through the open shutters is the number of the tens of the product. If this number is superior to 10, the figure at the left is carried forward and added to the figure of the hundreds, which is obtained by moving the carriage to the next stop at the left.

It is then sufficient to read the following:

First—*Through the units window of the carriage*, the tens figure of the product of the tens of the multiplicand by the units of the multiplier, then the units figure of the product of the hundreds of the multiplicand by the units of the multiplier.

Second—*Through the tens window of the carriage*, first the tens figure of the product of the units of the multiplicand by the tens of the multiplier; then, the units figure of the product of the tens of the multiplicand by the tens of the multiplier.

Third—*Lastly, through the hundreds window of the carriage*, the units figure of the product of the units of the multiplicand by the hundreds of the multiplier, and so on and so forth.

In conclusion, in order to make an operation with the "multi," the multiplicand is written on the first line of the cylinders by the successive rotation of the latter around their axis, then the multiplicator is written by opening the corresponding windows for each column of the carriage; the latter is then moved up by means of the tabulator stops, and after having sent it back to its normal position, the open windows are shut (by means of the blinds) and the machine can be used again.

Setting the "multi" preliminary to operation, showing the method of rotating the seven numbered axes to obtain the correct initial setting

A Bumper that Slides Along the Track

A BUMPER has been perfected that eliminates many of the dangers met with in the use of a rigid bumper for railroad cars. The one main advantage with the new bumper is that, when moving cars into track, the instant the first car strikes the shoes the whole crew knows it and they all realize that they are coming to the end of the track, and it is the engineer's duty to stop, whereas in the case of a rigid bumper, the first notification the crew has that the cars are at the end of the track is a sudden jolt, and with the coming of this jolt the damage has been done. With the use of most types of rigid posts there is always a possibility of injuring the post or displacing the track.

This bumper is designed to be used on the blind end of a track. The sliding shoe catches the car wheel and is forced along the rail, creating a very high friction which effectively retards the momentum of the car wheel within a rail length.—*By Geo. F. Paul.*

The bumper slides along the rail, but it stops the car within a rail length without excessive shock or strain

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

AEROPLANE.—W. F. OSBORNE, Wagon Mound, N. M. The invention relates more particularly to an aeroplane embodying means by which to counteract crossing on counter air currents, as well as to neutralize to a considerable extent the effect of striking air pockets. Among the objects is to provide means adapted to act as a stabilizing arrangement and to assist in both climbing and descent of the aeroplane, as well as to increase its normal capability as to safe maximum speed.

AIRSHIP.—K. A. ENLIND, South Nyack, N. Y. The invention relates generally to airships and more particularly to that type of airship embodying a part of longitudinal parallel rigid gas containers, the object being the provision of a construction applicable alike to large or small airships and of a nature which will afford maximum protection and safety with speed and effectiveness, especially as regards lateral stability.

Electrical Devices

ELECTRIC VAPORIZING GASKET.—W. KUTSCHE, 1302 Washington St., Lincoln, Neb. An object of this inveiton, shown in Fig. 4, is to provide a gasket to be clamped between the intake manifold and outlet of the carburetor, embodying an electric resistance disposed across the path of the fuel, to heat and vaporize the latter as it passes through, insulating pieces are laid above and below when the gasket is clamped between a manifold and carburetor.

COMBINED TOOL POUCH AND TESTING DEVICE.—A. E. SHARKEY, 263 No. Front St., Cuyahoga Falls, Ohio. A purpose of the invention is to provide a device which is simple and inexpensive, and which may be readily carried on the belt of a repairman in position to facilitate testing without removing the device, the tool pouch being also carried in convenient position to permit the ready insertion and removal of tools used in repairing of electric apparatus.

ELECTRIC STOVE.—A. C. HARRINGTON, Marion, Va. An object of the invention is to provide a simple compact electric stove in which the generated heat is under a much finer degree of control than is usually the case. A further object is to provide a thermostatic device and means whereby the heater circuit may be opened and closed at predetermined temperatures by the use of a simple means in connection with the thermostat.

CURLING IRON.—T. L. DENNIS, address Geo. F. Parker, 119 W. 42d St., New York, N. Y. An object of the invention is to provide an electrically-heated curling iron wherein the heating medium is so positioned as to produce the desired results without interfering with the movable parts of the iron. A further object is to provide a curling iron with a hair-retaining member, so pivoted that the thumb is raised only a minimum distance from the handle when actuating the same, and to offer as little obstruction as possible in curling.

Of Interest to Farmers

HOG FEEDER.—F. H. PAGE, Waverly, Iowa. The invention relates to a feeder in connection with a hopper and adapted to be actuated by the animal for feeding a limited quantity at each operation. An object is to provide a feed box with a flapper bar near the bottom in order to prevent the animals playing with the mechanism, and a covering member arranged with means for holding the same against removal, while allowing a partial opening for refilling purposes.

CLEVIS.—W. PORTER, R.F.D. No. 5, Aurora, Oregon. An important object of the invention is to provide a pin and clevis device of the type used as draft couplings in agricultural implements, vehicles, or the like, and which will prevent the accumulation of dirt, sand, or other foreign matter around the lock joint. Another object is to provide a device which is self-locking, simple, and in which there will be little liability of its catching on other working parts.

DEVICE FOR GRINDING TRACTORS.—E. E. PYLE, Morris, Ill. Among the objects of the invention is to provide a device for grinding tractors of various types in which means is provided for holding the steering apparatus used in plowing in such position as to keep one of the front wheels of the tractor in a furrow. The device can be quickly attached to the steering apparatus of a tractor without altering the structure in any way.

ATTACHMENT FOR FARMING IMPLEMENTS.—J. F. COOK, 846 Brunswick St., San Francisco, Calif. The purpose of the invention is to provide a simple attachment which can be applied to any standard form of two-wheel farming implement by a slight modification of the latter for converting the implement into a self-propelled one, or into a tractor which can be utilized for drawing farming implements. The invention further provides means for driving the wheels of the implement, such means being readily attachable and constructed to allow for differentiation in movement of the wheels.

PORTABLE IRRIGATION APPARATUS.—W. F. GRIFFIN, Watonga, Okla. The invention has for its object to provide a portable irrigation apparatus which is light in weight and which may be used economically for field crops. A further object is to provide the apparatus with a system of pipes, bound firmly together and mounted on standards provided with casters, it being possible to raise the pipes when they are to be moved to a new position, so that they will not interfere with the growing plants.

POWER-DRIVEN FARMING IMPLEMENT.—J. T. HICKMAN, Jr., Springport, Ind. The main object of the invention is to increase the range of use of the power-driven implement and bring about delicate directional control so that it can be turned practically in its own length with ease, and further objects relate to the mounting of the ground wheels whereby the machine may proceed without difficulty over uneven, rocky soil, avoiding injury from the encountering of obstacles.

MANURE REMOVER.—S. E. BROWN, R.F.D. No. 4 Middlesbury, Vt. The general object of the invention is to provide a flexible carrier adapted to operate in a trench beneath a stable and adapted to carry the manure therefrom outwardly, as well as to provide for automatically scraping the manure from the carrier to direct it into a wagon.

Of General Interest

PROTECTING DEVICE FOR FRUIT JARS AND THE LIKE.—C. W. YOUNG, 745 E. Julian St., San Jose, Calif. The primary object of the invention is to produce a device which may be applied to fruit jars to protect and prevent the same from cracking when hot fruit is poured into them. The device is extremely simple and consisting of a funnel, a protecting shield, and a supporting rod extending into the jar; it may be manufactured and sold at a low cost. (See Fig. 3.)

ATTACHMENT FOR T-STANDS.—J. S. ADAMSON, 223 E. Houston St., San Antonio, Texas. The object of the invention is to provide an attachment especially adapted for displaying compo-board and the like, but also adapted to display articles of merchandise of any character, and adapted to be attached to a stand having a vertical rod, in such manner that the attachment may be adjusted, easily attached to and removed from the rod, and the article adjusted toward and from the rod. (See Fig. 1.)

THREAD GUIDE AND SUPPORT.—J. W. OLIVER and H. BRUCKER, address J. W. Oliver, 16 E. 33rd St., New York, N. Y. This invention relates to a simple and economically manufactured thread guide and support which may be readily attached to the hand of the person using it and in which the thread is led from the spool through a guide or shuttle on the support in such manner as to eliminate any tendency on the part of the thread to unravel or snarl. The device, shown in Fig. 2, is made of aluminum, thus reducing its weight to a minimum.

SHAVING BRUSH.—P. P. PUPILLA, 813 Forest Ave., Bronx, N. Y. The invention relates to a brush by means of which it is possible to either apply soap to the bristles of the brush, or that portion to be shaved, and to mix a separate and independent lather for each person. A further object is the provision of a brush which will carry a supply of water, and provide an adequate amount instantly for use in forming the lather of proper consistency.

DISPENSING APPARATUS.—J. H. LIMPERT, c/o Limpert Bros., 625 Greenwich St., New York, N. Y. An object of the invention is to provide an apparatus whereby coffee-extract may be mixed with boiling water. Another object is to provide means whereby the proportions of water and coffee extract can be regulated by the manipulation of a single handle which controls the flow of the water and coffee into the receptacle.

SILO HOOP TIGHTENER.—W. ZULCH, Cobleskill, N. Y. This invention relates to hoop tighteners which will serve the double purpose of a tightener and a ladder. The device is comparatively easy to install, and, although primarily intended for use on silos, may be utilized successfully on vats or similar types of containers which employ hoops.

COMPOSITION FOR MATCHES AND PROCESS FOR MAKING SAME.—M. PRADOP, Santiago, Chile. An object of the invention is to provide a paste for matches which will have a low specific gravity and contains a minimum of potassium chlorate and a substance which will prevent the natural decomposition of the potassium chlorate. The composition contains such reactive materials as saw dust, coke, etc., which have a low specific gravity and are highly inflammable.

COMPOSITION OF MATTER.— S. BREITHOLTZ, 220 Madison Ave., New York, N. Y This invention relates to a composition to be baked into a pie crust; it consists of the following ingredients in about the proportions specified, namely, two cups of white flour, one cup of butter and two tablespoons of tea infusion, produced by soaking one-half teaspoon of tea leaves in a tumbler of water.

MANUFACTURE OF ALKYLENE CYANHYDRINS.—W. Bauer c/o Rohne & Haas, Darmstadt, Hessia, Germany. The process relates to the manufacture of alkalcyanhydrins from alkylenehalogrenhydrins and a solution of cyanid, characterized thereby that the change takes place in a pure water solution under the influence of cooling. The process of preparing ethylenecyanhydrin which comprises causing a re-action between ethylenebromhydrin and potassium cyanid dissolved in water, at a temperature of 55° to 60° C.

DOLL.—E. A. AHLER, c/o John A. Poulson, 5th and Market St., Chester, Pa. The prime object of the invention is to construct a doll in such a manner that any one of a plurality of facial expressions may be displayed at will. A further object is to so construct the head of the doll as to render the same capable of rotation about a vertical axis, to dispose one of the several facial expressions in display position.

ILLUSTRATED CODE.—L. HARMUTH, c/o F. Roch, 8 E. 13th St., New York, N. Y. This invention more particularly relates to a code for use in connection with wearing apparel. An object is to provide an illustrated code which will permit of a person sending a message in code form, which will relate to articles composed of a number of separate units grouped together to form a complete whole. Thus a person receiving the message will be enabled to comprehend what the sender desires.

LIGHT SHIELD.—O. P. SMITH, 23 Ricards St., Worchester, Mass. A nobject of this invention is to provide a device in the form of a strip which may be attached around the edge of a door frame to prevent light from passing through any cracks or crevices. A further object is to provide a strip primarily designed to keep undesirable light out of dark rooms, such as are used by photographers, which may be temporarily attached without scarring of the wood work.

CONTAINER.—C. H. CARTLEDGE, 5020 Saul St., Frankfort, Pa. The invention relates to containers more particularly adapted for containing and dispensing liquid products, such as salad oils, evaporated milk, syrups, etc. An object is to provide an effective draining of the contents to prevent waste in dispensing from the container by the flowing of the contents over the outer surface. The device is of ordinary construction, as commonly used, but with a vertically extending drainage channel in which an opening cut is made.

POURING ATTACHMENT FOR CANS.—G. C. SWEENY, 144 Columbia Heights, Brooklyn,

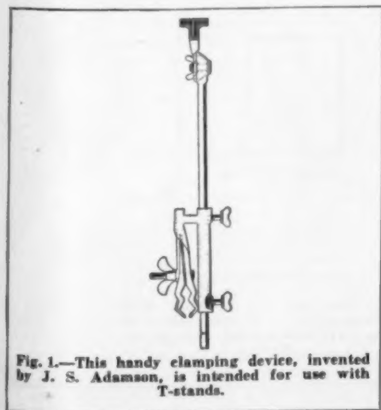


Fig. 1.—This handy clamping device, invented by J. S. Adamson, is intended for use with T-stands.

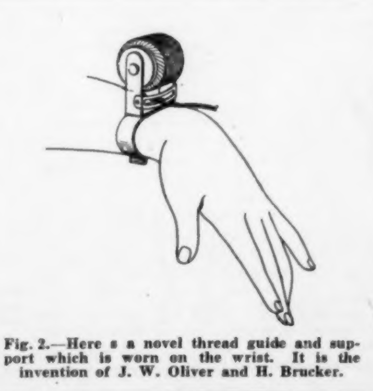


Fig. 2.—Here s a novel thread guide and support which is worn on the wrist. It is the invention of J. W. Oliver and H. Brucker.

Fig. 3.—This simple device serves to protect fruit jars from cracking when pouring hot preserves into them. It is the invention of C. W. Young.

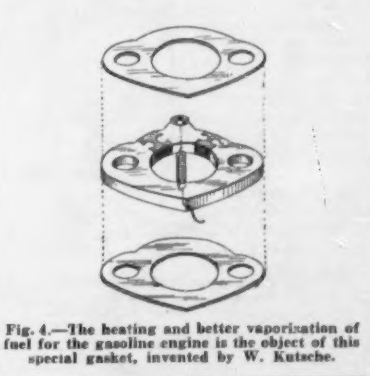


Fig. 4.—The heating and better vaporization of fuel for the gasoline engine is the object of this special gasket, invented by W. Kutsche.

N. Y. The invention relates to pouring attachments for metal cans, commonly employed for shipping gasolene, oil and other liquids. An object is to provide a device in which a reversible funnel facilitates the filling and emptying of the container. A further object is to provide a pouring attachment which will be simple, strong and comparatively inexpensive to manufacture.

FILM-FEED APPARATUS FOR PROJECTION DEVICES.—C. H. MCQUILLAN, c/o Press Gazette, Green Bay, Wis. The purpose of the invention is to provide a film holding and feed device from which the film may be fed from its center into and through the projecting box and from the latter on to a take-up wheel, the hub and one side of which are detachable with respect to the opposite side so that the film may be bodily removed and reinserted in the feeding reel or holder.

BASKET.—C. F. ROTHWELL, Columbus, Mont. The object of the invention is to provide what is known in the undertaker's business as a "pick up" basket. A further object is to provide means whereby the manual lifting of a corpse from the basket on to the embalming table is eliminated and the operation thus made more sanitary, and the danger of spreading disease lessened.

TOW LINE.—J. DUGGAN, R.F.D. No. 2, Watervliet, Mich. The invention relates to tow lines particularly adapted, although not necessarily, for use in hauling stalled motor cars, a purpose being to provide a simple line comprising a main section, and branch sections having their free ends formed with eyes, and having knotted ends, adapted to extend through the eyes and locking blocks, slidably fitted on the eyes for locking the knotted ends with the eyes.

CLIPPING DEVICE.—W. GOWER, 90 W. 11th Ave., Tampa, Fla. This invention relates to hand-operated clippers adapted for use in gathering fruit, flowers, and the like, from trees and bushes. The purpose is to provide a clipping device which is of extremely simple and inexpensive construction, and capable of being secured to the hand and operated by the thumb and forefinger, leaving the three fingers and the palm of the hand free.

PROCESS OF MAKING ARSENATE OF LEAD.—M. L. TOWER, address The Niagara Sprayer Co., Middleport, N. Y. The invention has for its object the production of a soft, fine, precipitate of arsenate of lead which is suitable for use as an insecticide with little grinding. Another object is to provide a process in which a means is provided for reducing the percentage of soluble arsenate in the insecticide below the amount which is permitted by the laws controlling the quality of insecticides.

PROCESS OF MAKING LEAD ARSENATE.—M. L. TOWER, address The Niagara Sprayer Co., Middleport, N. Y. The invention relates more particularly to a process of the class indicated in which a catalyst is used to hasten the reaction between the litharge and arsenic acid. An object is to produce lead arsenate having a low solubility, so that the recovery in filtration will be maximum, and the lead arsenate especially suitable for use as an insecticide.

CARPET OR THE LIKE MOUNTING FOR STAIRWAYS.—C. D. ARMSTRONG, 2403 Harrison St., San Francisco, Calif. The invention relates to means for mounting carpet or the like on stairways, and has reference more particularly to a plate made to receive the strips of material to be mounted and maintain them in fixed relation, relative to the steps to be covered. The primary object is to provide a simple means of repairing steps in which the carpet or covering has become worn.

THREAD GUIDE AND SUPPORT.—J. W. OLIVER, 16 E. 33rd St., New York, N. Y. This invention has for an object to provide a light support in which the liability of the thread to snarl or become unreeled from the spool beyond a required amount is prevented, and by reason of the narrowness of the aperture through which the thread passes it will meet with more or less friction, thus will not run too freely. The device is constructed to be worn on the wrist for the user.

COMB.—O. R. ALTWEIN, P. O. Box. 798, Asheville, N. C. The invention relates more particularly to combs designed for straightening kinky hair, an object being to provide a comb in which a movable member operates to clamp or frictionally bend the hair between the same and teeth of a stationary member, so that, when the comb is moved through the hair, it will operate to straighten the hair, especially when the comb is heated.

SMOKING PIPE.—H. J. MCGUCKIN, 668 8th Ave., New York, N. Y. Among the objects of the invention is to provide a construction wherein the tobacco is protected at all times and is positioned so that the smoke will readily pass out of the mouthpiece. Another object is to provide a round-shaped bowl with an opening in line with the mouthpiece, whereby a good draft will be produced and the tobacco will be protected against rain.

GAZING BOWL.—L. M. ANDERSON, Box 31, Station I, New York, N. Y. In general the invention relates to a receptacle having a highly polished interior surface, which may be filled with liquid to form a reflecting surface into which a person, using the device, may gaze, whereby the concentration of their thoughts may be assisted. Another object is to provide a receptacle which is artistic and ornamental.

Hardware and Tools

TOOL.—A. J. BURKE, 105 Plymouth St., New Haven, Conn. The invention relates to an auger which is especially constructed for boring through seams or season-checks, an object being to prevent the chips or borings lodging in the seams and clogging the tool causing a loss of time to the operator, the upper edges of the tool is formed with a series of teeth and upon being actuated in the usual manner any chips will be effectually removed from the bore. (See Fig. 6.)

CONTROLLING MEANS FOR SPRING OPERATED FAUCETS.—G. A. HICKMAN, Box 634, Pearl River, N. Y. This invention, shown in Fig. 5, provides a device of simple and durable construction, reliable in operation, easy and inexpensive to manufacture, and effective to control the flow from the faucet, so as to maintain and vary the flow as desired. The controlling means includes a swinging cross head, a clamping bar, carried by said cross head and a clamping screw carried by the clamping bar for engaging the spring faucet.

LEVEL HOLDER.—F. BUTLER, Panama Hotel, 403). 5th St., Los Angeles, Calif. An object of the invention is to provide a level holder which will receive the ordinary type of pocket spirit level and support the same against a straight edge, so that the level can be used on an extended surface. A further object is to provide a device which can be manufactured and sold at an extremely low price.

LOCK.—F. J. DOWLING, 425 W. 124th St., New York, N. Y. Among the objects is to provide a lock having safety means serving automatically to close the key opening in the event that the key barrel is severed from the lock. A further object is to provide means whereby the sliding or bolt portion may be held in either of two positions, one of which is for holding the bolt projected in position to be further projected by the door jamb, the other position is to prevent cooperation with the door jamb device.

WOOD SAW.—R. A. HEISEL, c/o Eli Jones, Luverne, Minn. This invention relates more particularly to a pole or core-wood cross cut saw, an object being to provide means for preventing rattling, vibration and lateral displacement of the saw frame and means for facilitating the movement of the saw frame during its operation. A further object is to provide a saw which is strong, durable and capable of adjustment.

CROSSCUT SAW EQUALIZER.—L. E. KILLIAN, Fillmore, Ill. An object of the invention is to provide an attachment for cross-cut saws which will enable a single operator to efficiently operate the saw, giving him the necessary purchase and leverage so that he can effectively use the saw in any cutting position. A further object is to provide an equalizer which can be conveniently attached to any ordinary saw.

CALIPERS.—W. H. HARRIS, Laurium, Mich. The primary object is to provide a caliper in which the legs thereof are automatically maintained in contact with the work by mechanical means instead of depending upon the gripping action of the hand of the operator, as is the common practice. The device is particularly adapted for determining and marking the center of a body for which purpose a centering rod is provided.

GATE VALVE.—J. C. SMITH, 55 John St., New York, N. Y. The invention particularly relates to outside screw and yoke gate valves using a yoke sleeve or bushing. An object is to provide a gate valve whereby the yoke sleeve or bushing can be readily removed, replaced or repaired without disturbing the yoke, whether the latter is cast solid with the bonnet or forms a separate part.

PIPE PATCH.—W. L. LONG, R.F.D. No. 1, Independence, Kans. The object is to provide a pipe patch for repairing leaks in gas and water pipes. The construction combines a curved patch plate and the gasket of a clamp comprising a U-shaped yoke and a cooperating presser bar being interengaged at one end, the presser bar having an eye at its opposite end, receiving a threaded end of yoke, and a nut, holding said eye in position on the yoke.

Heating and Lighting

FURNACE.—M. J. GRANEY, 733 Lockhart St., Pittsburgh, Pa. The invention relates more particularly to hot air furnaces for burning natural or coal gases, the purpose being to provide a simple, durable and inexpensive furnace having a hot-air chamber and gas passages so associated therewith as to transmit to the chamber with the greatest degree of efficiency all the heat generated by the burning gases without the latter coming in actual contact with the air to be heated.

HEATING DEVICE FOR EVAPORATORS, PARTICULARLY EVAPORATORS FOR DRYING FRUIT.—F. WILLIAMS, 90 King William St., Adelaide, South Australia, Australia. The invention particularly relates to evaporators for treating and drying fruit, and it has been especially devised in order to provide devices whereby the air in the evaporator may be heated evenly and effectively without contact with the furnace gases, through sets of vertical tubes arranged in rows transversely, there being two or more rows of tubes in each set, the tubes being staggered relatively to the next row.

Machines and Mechanical Devices

PLAITING MACHINE.—O. and L. E. ODLE, 1825 S. 9th St., Waco, Texas. The object is to provide a plaiting machine which efficiently folds or plaits the cloth in accordion or other desirable style of plaiting, which applies heat and an ironing pressure to the cloth during the operation and which is of simple and durable construction, reliable and easy and inexpensive to manufacture and maintain.

FRICTION TRANSMISSION MECHANISM.—H. MCDERMOTT, 336 W. 4th St., Leadville, Colo. Among the objects of the invention is to provide a device in which means are provided for imparting a driving force from the drive shaft to a shaft to be driven without the use of the usual gears, chain and sprocket mechanism, or belt and pulley device. A further object is to provide for reversing the direction and varying the speed.

ICE CREAM SANDWICH MACHINE.—R. H. PROPER, Box 410, Gen'l P. O., New York, N. Y. An object is to provide a simple hand-operated utensil adapted to be plunged into a container of ice cream, carrying with it one biscuit, and so designed as to receive a film of ice cream of suitable thickness to constitute the filler between the biscuit and a second biscuit which will be applied to the face of the cream after the device is withdrawn from the container.

RACK EVAPORATOR.—F. WILLIAMS, 90 King William St., Adelaide, South Australia, Australia. The invention relates to an evaporator of the type known as rack evaporators, and it has been especially devised to provide an evaporator with which the drying processes may be completed in one building; the device has been particularly constructed for drying fruits, but may be readily adapted to treat other materials. The evaporator comprises a preparing room, sulfur chamber, a wilting room and an evaporator chamber.

ROTARY DUPLICATOR.—L. P. BOSC, 23 Rue Notre-Dame de Recouorance, Paris, France. This device may be applied to all kinds of rotary duplicators in which stencils are employed; it relates more particularly to an apparatus designed to effect a uniform inking of the inner surface of the cylinder and the removal of all excess of ink, returning the excess ink into the ink-box and cleaning the cylinder after the copies have been made.

PAPER-MAKING MACHINE.—L. E. MILKEY, Box 251, Sandusky, Ohio. Among the objects is to provide means for removing the moisture from paper fabric while it is moving in the form of a sheet. A further object is to provide a blow roll against which paper, fabric, etc., is smoothly held between perforated aprons, strips, or conveyers, so that air of any desired temperature can be forced through or into contact with the sheet to remove the moisture therefrom. The device may also be utilized as a conveyer for chemicals for disinfecting, or liquids for coloring the sheet.

AUTOMATIC SCALE.—A. and A. T. MCLEOD, 532 W. Marquette Ave., Chicago, Ill. An object of the invention is to provide an automatic scale adapted primarily for weighing coal, but not confined to this kind of material, arranged to continuously weigh equal quantities in an intermittently running stream. A further object is to provide a starting and stopping mechanism, the co-acting parts being respectively made to operate by the coal-discharge valve and the scale beam, the two performances taking place automatically.

ROCK DRILLING MACHINE.—R. A. KRAMPITZ, Valdez, Territory of Alaska. An im-

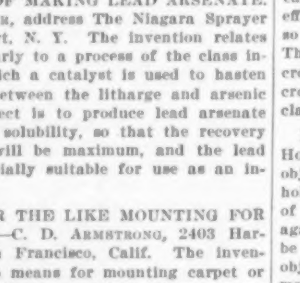


Fig. 5.—An ingenious controlling means for spring operated faucets, invented by George A. Hickman.

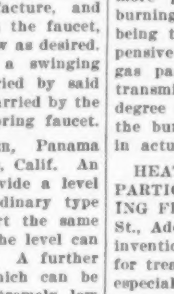


Fig. 6.—The object of this tool is to produce an auger that does not clog with its own chips. It is the invention of A. J. Burke.

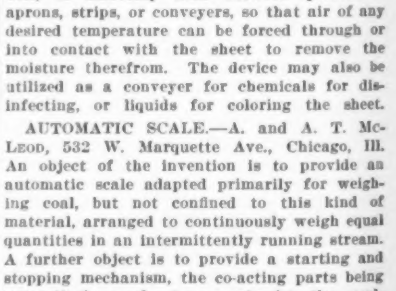


Fig. 7.—This jack of the lever hoist type, invented by T. A. Lake, serves to jack up light automobiles, such as the Ford.

portant object is to provide a machine in which the power may be applied direct to the drill through a positive mechanical train to impart uniform, constant and efficient operative movement. Another object is to prevent severe unusual and destructive stresses from being set up in the drill by automatically releasing the power when the drill is jammed, caught or otherwise held against its normal operative movements.

AUTOMATIC VALVE CONTROL.—T. CURRAN, Colonial Hotel, Chillicothe, Ill. This invention relates to valve control mechanism. An object is to provide a device by means of which a valve, such as that leading from a sludge-treating tank, may be operated automatically and periodically without any attention, the operation being by hydraulic means, thereby insuring the positive opening and closing of the valve.

STEAM ECONOMIZER.—J. L. BARRETT, 953 So. 2nd St., Plainfield, N. J. The object of this invention is to provide a device of the character specified, adapted for use with steam engines and to be arranged between the boiler and the engine for conserving the exhaust from the engine and returning it to the boiler for re-use before the exhaust has lost its heat.

MOTOR-BEARING-BURNING-IN STAND.—H. VATTER, c/o Wray-Dickinson Co., Inc., Shreveport, La. One of the principal objects of the invention is to provide a stand of the nature set forth, consisting of a hinged table, for securing the cylinder block in place on the stand in such manner that the cylinder block is made accessible for inspection, assembling, removal, adjusting or fitting of parts, without removing the block from the machine.

LABELING MACHINE.—J. Q. LEAVITT, address Herbert L. Harrington, c/o Utah Canning Co., 29th St. and Pacific Ave., Ogden, Utah. An object of the invention is to provide means for feeding cans onto a track and for moving the track vertically, so that the cans receive first a daub of paste, then a label, and then a smoothing or pressure brush, to firmly apply the label to the can, all of said mechanism operating in unison and simultaneously the several operations taking place at different stations.

LAWN MOWER ATTACHMENT.—W. J. BOLL, Platteville, Wis. The invention relates to a blade-adjusting mechanism for lawn mowers, particularly those types of mowers which employ series of rotary blades, operating with a fixed blade to sever the grass. An object is to provide an adjusting mechanism which will be simple in construction and adapted for use with many mowers now on the market, and which will not greatly increase the selling price of the mower.

EXTRACTING APPARATUS.—J. B. JENSON, 824 McIntyre Bldg., Salt Lake City, Utah. An object is to provide an eduction apparatus for extracting volatile and liquid substances from solids and more particularly oil from oil shale and sand, or the like. Another object is to provide an apparatus whereby practical recovery may be accomplished, the apparatus being formed in sections or independent units, connected in series, so that the size and capacity can be easily varied.

Medical Devices

STRINGED INSTRUMENT.—W. A. VINSON, 619 No. Calvert St., Baltimore, Md. The invention has for its object to provide a string instrument by means of which a large variety of sounds and of musical tones may be produced, and which may be operated in a variety of ways. A further object is to produce an instrument wherein the tension of the string may be constantly varied to produce sliding tones, commonly called jazz.

BED PAN.—E. D. ABRAHAM, 2859 W. Madison St., Chicago, Ill. Among the objects of the invention is to provide a bed pan having a removable waterproof lining which may be burned, thus making the pan more sanitary. A further object is to provide an inexpensive lining which is convenient to handle and which will render the washing of the pan unnecessary.

Musical Devices

MODULATING DEVICE FOR SOUND REPRODUCERS.—G. S. PEASE, Colonia, Wis. This invention relates to phonographs and similar sound-reproducing machines, its object is to provide a modulating device for sound reproducers, arranged to enable an operator to vary the vibratory action of the diaphragm at will. Another object is to permit of conveniently attaching the modulator to sound reproducers as now generally constructed.

Prime Movers and Their Accessories

INTERNAL COMBUSTION ENGINE.—E. L. MALSBARY, Fairfax, Calif. An object is to provide an engine of the two-cylinder type which is scavenged as completely as an engine of the four-cylinder type. A further object is to provide a device in which the explosive charge is forced through the hottest part of the motor, thereby not only rendering the fuel more easily ignited and consumed, but also tending to cool the engine.

SPARKING PLUG WITH SELF CLEANING ELECTRODES.—B. SCHERER, La Garrenne Colombes, Seine, 28 Boulevard National, France. The invention relates to sparking plugs used for the ignition in internal combustion motors; it is more particularly characterized by the fact that one of the electrodes is movable or that both electrodes are movable relatively to each other. The arrangement has for its object to perform a self-cleaning of the parts upon which the spark takes place, thus favoring the operation of the motor.

POWER PLANT.—O. K. BOGSTRAND, 4810 6th Ave., Brooklyn, N. Y. This invention relates to internal combustion engines, and has in view to furnish a combustible fuel at reduced cost, to conserve the heat units employed in the production of said fuel, to vary the quantity of fuel during the period of employment thereof and to employ the surplus heat incident to the formation of said fuel for various purposes.

Railways and Their Accessories

RAILWAY CAR WHEELS AND AXLE.—T. LITTLEFIELD, Exira, Iowa. The purpose of the invention is the provision of a special form of car wheels and means for supporting them on an axle, whereby the wheels can rotate together when traversing a straight stretch of tract and independently of each other when traversing a curved stretch, thus allowing the rotation of the wheels at different speeds when rounding curves and thereby preventing the uneven wear of track rails.

SAFETY ATTACHMENT FOR AUTOMATIC TRAIN STOPS.—M. B. BULLA, 209 Caples Bldg., El Paso, Texas. Among the objects of this invention is to provide automatic train control mechanism, including a normally closed circuit, the breaking of any part of which will insure the stopping of the train. A further object is to provide electric controlled means whereby the engineer under orders may pass a danger point.

RAILWAY TRUCK.—S. B. BRILHART, 214 W. 127th St., New York, N. Y. Among the objects of the invention is to provide for a jointed car or structure of supporting trucks with operative connections between truck portions, which serve to control the alinement of the several truck portions with the rails under all service conditions, there being provided rod and lever connections, whereby the swinging of either main truck, due to its taking a curve, will cause a certain swinging movement of the center truck.

Pertaining to Recreation

GAME APPARATUS.—A. O. COULLIARD, 73 Pine St., Milford, Mass. This invention relates to a game apparatus in which the operator endeavors to assemble certain eccentrically movable members within a fixed space on a field. An object is to provide a game which will prove interesting and amusing, at the same time will require great skill on the part of the operator.

BATHING BOAT.—J. SEBETO, 553 6th Ave., Brooklyn, N. Y. The general object of the invention is to provide a structure adapted to afford amusement as well as exercise. The structure includes a hull composed of airtight compartments having a well extending therethrough and a seat to accommodate the user, a paddle wheel in the front of the well, and levers with hand-holds for actuating the paddle, and a rudder adapted to be operated by elbow pressure.

AMUSEMENT APPARATUS.—F. W. THOMPSON, Dec'd, address Mrs. Selene P. Thompson, administratrix, 350 W. 55th St., New York, N. Y. The object of this invention is to provide an amusement apparatus for use in pleasure resorts, exhibitions, fairs and other places, and arranged to accommodate a number of passengers at a time and to give the passengers the illusion of a trip in an aeroplane; another object is to render the apparatus portable from one place to another, and to allow of setting the same up in a tent or other structure.

MECHANICAL TOY.—P. A. MARSHALL, 3501 Paloma St., Los Angeles, Cal. The invention has for its object to provide a toy wherein there is provided a rotatable support carrying a series of representations of airplanes, so connected with the support that they may move upwardly and downwardly with respect thereto, the downward movement of the one controlling the upward movement of the other, and also controlling the rotation of the support.

Pertaining to Vehicles

JACK.—T. A. LAKE, Hillman, Mich. The invention relates to a jack of the lever hoist type. An object is to provide a lifting device which is especially adapted for use with the ordinary Ford type of automobile, which can be used to raise the forward end of the body of this type of car, take the weight off the springs and allow the springs themselves or the truss rods connected with them to be removed and replaced. (See Fig. 7.)

BICYCLE PROPULSION GEARING.—G. H. W. DOOSE, 311 Olivia St., Algiers, La. The invention particularly relates to that type of gearing wherein multiplying gears are interposed between the sprocket-wheel on the crankshaft, and that on the rear wheel for the purpose of speeding up or driving the propelling wheel at a higher speed than the crank-shaft. The object is to provide a device wherein a high speed and increased power are attained without the necessity of rapid pedaling.

CRATE.—M. R. MOFFITT, Peck, Kans. The object of the invention is to provide a device especially adapted for use with motor vehicles, and to be arranged upon the running board of the vehicle, and having means for clamping the same. The crate is composed of detachable sections permitting it to be quickly assembled for use or disassembled for storage.

DIRECTION-INDICATING SIGNAL FOR AUTOMOBILES.—A. E. BELLER, 508 31st St., Ogden, Utah. This invention has for its object the provision of a manually operable signal of simple, durable and efficient construction, which is attachable to the cowl of an automobile, so that the operator can readily manipulate the indicating arm to signal the direction in which the vehicle is about to turn.

VEHICLE WHEEL.—A. B. FUHR, City Court of Macomb, Macomb, Ill. An object of this invention is to provide a wheel for automobiles and other vehicles which contains in itself spring means interposed between the rim and the spokes, spaced at equal distances apart, thereby effecting a multiplied resilience at the rim relative to the resilience given out by the springs employed.

DIRIGIBLE HEADLIGHT.—G. F. MESSER, 304½ E. Heron St., Aberdeen, Wash. Among the objects of the invention is to provide a headlight which will automatically swing the lights horizontally with the front wheels of the vehicle to maintain the light beams parallel with the plane of the front wheels, and which may be manually operated to swing the lights vertically. The device is adapted to be associated with various types of motor vehicles.

AUTOMOBILE BODY AND TOP THEREFOR.—C. T. SILVER, 100 W. 57th St., New York, N. Y. This invention has for its object to provide an automobile body having an opening for receiving the top when it is lowered, means being provided for closing the opening after the top has been raised or lowered to the desired position. Another object is to provide a top which will fold to permit of the stowing in the opening in the body of the machine.

STEERING-WHEEL LOCK.—G. A. WEHNER, 420 Habersham St., Savannah, Ga. The primary object of the invention is to provide a simple, inexpensive mechanism carried by a cap engageable with and disengageable from the gear housing of the steering post, whereby the steering wheel may be latched in its active position in a readily releasable manner and locked in its raised or elevated position where it is inactive.

WORK AND DISPLAY STAND.—P. H. and J. H. GARTNER, address John H. Gartner, Lava Hot Springs, Idaho. This invention relates to a stand which is capable of grasping and retaining any type of automotive vehicle and by means of which the vehicle may be moved readily to a position in which its under side will be easily accessible for repairing or display purposes, and which is so simple in construction and operation as to be capable of being manufactured at a low price.

WHEEL.—H. D. REY, Rey Wheel Co., 318 Park Bldg., Detroit, Mich. The object of the invention is to provide a wheel adapted for use in any connection, composed of a hub, a rim and a spoke portion, which consists of two sections, formed from sheet steel, pressed or stamped to shape and adapted to be fitted on the hub and to engage the rim, and to cross each other between the hub and the rim, and to be pressed together to engage the hub and rim and support the hub from the rim.

WHEEL-CHAIN LIGHTENING TOOL.—Z. A. LAVOIE, address J. E. Lachance, Manchester, N. H. The invention relates to tools adapted for use in the tightening and adjusting of wheel chains of the Weed type, so that they can be properly fitted to the tire. A purpose is to provide a tool which is extremely simple in construction, yet is effective in its work of tightening the chain.

VARIABLE SPEED POWER TRANSMISSION.—O. S. PULLIAM, Room 2528 Park Row Bldg., New York, N. Y. The primary object of the invention is to provide a driving mechanism particularly adapted for use in self-propelled vehicles; a further object is to provide a device which will not only replace the differential mechanism commonly employed, but is also capable of providing for a change of driving speeds, thus eliminating the necessity of the transmission mechanism usually employed. A still further object is to so construct the device that a wide range of speeds may be obtained.

HAND WHEEL.—H. W. DOVER, Holywood, St. James, Northampton, England. This invention relates to hand wheels such as are employed for steering motor vehicles, controlling aircraft, motor boats, gun mechanism, and for other purposes, and has for its object to obviate or reduce the use of cast parts. The hub is formed with a groove adapted to receive the inner ends of the spokes, said groove being bounded on two of its sides by flanges, adapted to be pressed toward one another so as to fit closely around the spokes.

TRACTOR WHEEL.—E. H. WHITING, R.F.D. No. 3, Box 501, Santa Rosa, Calif. One of the principal objects is to provide a tractor wheel with means for automatically cleaning the same upon each revolution. The invention further contemplates a wheel having tractor elements which are capable of radial projection from the tread and means for projecting such elements at their point of contact with the ground, said means also serving to retract the elements to permit a scraper to co-act with the tread for clearing the same of earth adhering thereto.

Designs

DESIGN FOR A JAR.—J. M. LUCHESSA, Cambria, Calif.

DESIGN FOR A COMBINATION CHECKER BOARD AND TRAY.—A. M. DEIG, 522 Jefferson St., Seattle, Wash.

DESIGN FOR A RULE HOLDER.—T. D. FREDERICK, 330 Connecticutt St., San Francisco, Calif.

DESIGN FOR A SIFTER TOP RECEPTACLE.—M. WOLF, 1186 Tinton Ave., Bronx, N. Y.

DESIGN FOR A SPOON HANDLE.—T. A. WILLIAMS, Battle Ground, Wash.

DESIGN FOR A COVER.—S. GEISMAN, c/o Geisman, Musker & Brightman, 27 Spruce St., New York, N. Y.

DESIGN FOR A POWDER CONTAINER.—C. S. HUMPHREY, Bush Terminal Bldg. No. 10, Brooklyn, N. Y.

DESIGN FOR AN ELEVATOR SIGNAL.—P. S. VAN BLOEM, The Viking Sign Co., 617 8th Ave., New York, N. Y. The inventor has been granted patents of three designs of a similar nature.

Our Readers' Point of View

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Transparency of Moving Automobile Wheels

To the Editor of the SCIENTIFIC AMERICAN:

Some time ago a reader of the SCIENTIFIC AMERICAN asked why the upper part of a moving automobile wheel appears more transparent than the lower part. The question was answered in the SCIENTIFIC AMERICAN for January 22, 1916, p. 113, answer 14026, and was further discussed by Mr. Albert J. Dow in the SCIENTIFIC AMERICAN SUPPLEMENT for April 1, 1916, p. 215. G. W. C., who asked the question, stated that photographs of automobiles going at fifty or sixty miles an hour sometimes show the lower part of a wheel clearly, but give the impression that the upper part of the wheel is transparent. Mr. Dow also speaks of the "commonly noticed phenomenon that the top of the wheel is the most transparent." The explanation given by the Editor of the SCIENTIFIC AMERICAN, and amplified by Mr. Dow, is that the upper part of the wheel is moving faster than the lower, and therefore that a spoke in the upper part of the wheel passes an object more quickly than a spoke in the lower part of the wheel.

For some time I have been trying to observe this effect, and I must confess that I do not see it. The top of a wheel looks no more transparent to me than the bottom. Is there something the matter with me, or is there something the matter with the explanation that has been given? I think the trouble is with the explanation.

The upper part of a wheel does, of course, go faster than the lower part. But not only does a *spoke* near the top of a wheel move across an object more quickly, but so does the *space between spokes*, so that on the whole an object behind the wheel is obscured by spokes for about the same fraction of the time whether it is behind the upper part or the lower part of the wheel.

To see how the width of a spoke affects the result consider the point A in the figure. Let a stand for the radius of the wheel, r for the distance from the middle of the axle to the point A, b for the width of a spoke, θ for the angle which the spoke makes with the vertical, $\dot{\theta}$ for the angular velocity of the spoke with reference to the car, and V for the linear velocity of the car. Then the velocity of A with respect to the ground is the resultant of the horizontal velocity V of the car and the velocity, $\dot{\theta}r$, with which the point A is moving with respect to the car. But $V=\dot{\theta}a$, so that the horizontal component of the velocity of A is

$$\dot{\theta}a+\dot{\theta}r\cos\theta.$$

Now a horizontal section of the spoke has a width $b/\cos\theta$, so that the time during which a point behind the wheel is shut out from view by the spoke is

$$\frac{\text{horizontal width of spoke}}{\text{horizontal velocity of spoke}}=\frac{b}{\dot{\theta}\cos\theta\,(a+r\cos\theta)}$$

Similarly, if c represents, at the distance r from the axis, the clear distance between one spoke and the next, the time during which a point behind the wheel can be seen between two consecutive spokes is very nearly

$$\frac{c}{\dot{\theta}\cos\theta\,(a+r\cos\theta)}.$$

On dividing expression (1) by expression (2) we find that the ratio of the time during which a point cannot be seen to the time during which it can be seen is approximately b/c. This ratio does not depend on whether the object observed is behind the upper part of the wheel or the lower part, but it does depend on the distance from the axis. The wheel should therefore appear more transparent near the rim and less so near the hub. And that is the way it looks to me.

Now what about the photographs which showed the lower part of the wheel clearly and the upper part not clearly? These photographs were, of course, taken with short exposures, and during the time of exposure the lower part of the wheel had moved only a little and the upper part had moved farther. That is, the explanation that was given by the Editor of the SCIENTIFIC AMERICAN does apply to the photographs. If we could make a sufficiently short and sufficiently intense exposure on the retina we ought to be able to see the lower part of the wheel more clear and the upper part more transparent. I have attempted to get this effect by closing my eyes when a car was approaching, and then quickly opening and closing them again while looking toward a wheel. But I am not usually successful in seeing the effect that G. J. C. says the photographs show. One reason for the failure of the eyes to observe this effect seems to be that when the eyes are exposed for so short a time details cease to be visible. A second reason is to be found in the tendency of the eyes to follow the car, in which case the effect will, of course, not appear. A third reason, I think, is the smallness of the space that can be clearly seen at one time. Thus on quickly opening and closing my eyes when I have happened to be looking toward the upper part of a wheel I have sometimes seen—or at any rate have thought that I have seen—the upper spokes more clearly than the lower.

ARTHUR TABOR JONES.

Smith College.

Peculiar Action of Rotating Cardboard Discs in Air

To the Editor of the SCIENTIFIC AMERICAN:

As a subscriber to your journal in a remote corner of the world, I have read with interest an article therein some few months ago relating to the action of currents of compressed air on balls and discs. The experiment particularly in mind is one in which by blowing through a tube, with a disc-like flange on one end, upon another disc of cardboard, the latter instead of being blown away as one would expect, approaches the flange end of the tube from which the air current is issuing, with considerable attractive force.

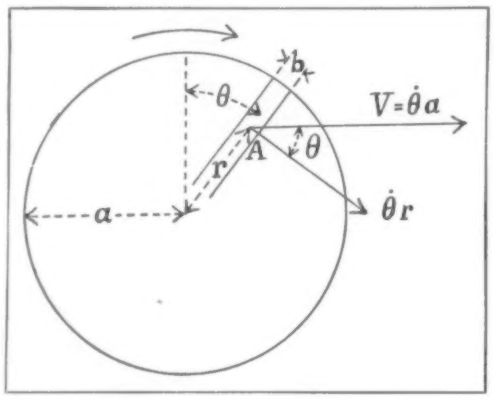
After performing the experiment satisfactorily for my amusement, I attempted to investigate the action of air on moving discs, the crude results of which may be of interest to your readers.

Having mounted a cardboard disc eight inches in diameter upon the spindle of a small electric motor running about 3,000 R.P.M., rotating the disc in its own plane above its axis, tests were made upon both sides of same, for signs of vacuum effect, by means of strips of paper held more or less closely to the rotating disc. Considerable attractive force was found, strongest towards center of disc, and equal on both sides, the attractive force coming into play fairly abruptly about one-eighth inch from surface of disc, which seemed to point to something more than air currents produced by the centrifugal action of the rotating disc. Again, upon presenting a larger cardboard disc 12 inches in diameter, held parallel to the plane of the rotating one, and approached to a position about one-eighth inch from same, a strong attractive pull was obtained, registering about one-quarter pound. It occurred to me that if the attractive force upon one side of the disc could be neutralized, and the corresponding force upon the other side be allowed independent action a new lifting or propelling means for airships might be evolved. My experiments in this direction were too crude for satisfactory results.

Another experiment made with a number of discs mounted loosely on the motor spindle, free to approach or retire from one another, showed that these discs rotating in a medium such as air, immediately and strongly attracted one another, always tending to form one disc. If revolving discs in air will gravitate, as it were, to one another, why should not revolving atoms in the ether do likewise?

CHARLES JOHNSON.

Hobart, Tasmania.



Energy from Waste Water

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of May 7th, 1921, is an article entitled "Electric Light From Waste Pipe Flow," being a quotation from an article presented by M. E. Colardeau at a meeting at the Academy of Sciences, at which he is reported to have made a statement to the effect that many millions could be saved yearly by the utilization of the energy from tap water in houses.

He makes the statement: "If the water flows, as is usual from a cistern five meters above and at the rate of one liter per second, this flow provides sufficient power to keep charged accumulators necessary for the lighting of 20 lamps of 10 to 50 candle power each."

The problem of investigating the possibility of obtaining energy from the water supply of a household may be taken up in four ways:

1. A checking up of a statement of M. Colardeau, using the factors of a fall of five meters and the rate of use of one liter per second, and as a part of the answer find what one liter per second means in consumption per capita.

2. By a computation of the amount of energy obtainable from the amount of water ordinarily consumed by an American household at an ordinary pressure at which the water is supplied.

3. By a computation of the amount of water required at an ordinary pressure to supply the electric current used by an ordinary American household and as a part of the answer find the effect on the water supply system of a community by any such requirement.

4. A comparative estimate of the cost of the electric energy obtained as in 3 with the cost of electricity obtained from a central power station. I will give the solution of the problems in the order presented.

1. One liter per second is equivalent to 61.023 cubic inches divided by 231 equals .264 gallons per second or 22,810 gallons per 24 hours. In a family of four this would mean a daily consumption of water of 5,702 gallons per person against an ordinary consumption of 100 gallons per person, which is considered an ample supply. It will be readily seen that the use of any such volume of water as called for by the first problem requiring 57 times as much water as is ordinarily consumed would mean an immense enlargement of existing systems of water supply if this plan of obtaining electric energy should be universally adopted.

2. The amount of water consumed per capita per day in an American family is frequently taken as 100 gallons, while my personal observation and measurements indicate that 50 gallons are amply sufficient where there is no allowance for leakage in mains, but for this problem let us assume the use of the larger amount. In a family of four this would mean a daily requirement of 400 gallons. Say this could be delivered at a pressure of 60 pounds to the square inch and that the full measure is available.

If the water could all be drawn in one hour we would have a use of 400 gallons ÷ 7.48 = 53.5 cubic feet per hour equivalent to .015 cubic feet per second. Sixty pounds' pressure is equivalent to a head of 138 feet. With a water motor of 75 per cent efficiency the power of this water at this head will amount to .015 x138x.085=.176 horsepower for one hour, equivalent to .132 kilowatt hours or enough power to light 3.3 forty watt lamps for one hour, making no allowance for losses in electric generator, wiring or storage batteries. What American family would be satisfied to use but three forty watt lights for one hour, or even one such light for three hours, on a Winter's evening?

3. I am informed by central station operators that the ordinary consumption of electricity by an American family of four in the Winter months is approximately one kilowatt hour per day. This is equivalent to 1-1/3 horsepower hours and if as before we assume that water is delivered at a pressure of sixty pounds per square inch, equivalent to a head of 138 feet, with no losses by friction, this 1-1/3 horsepower hours would require .113 cubic feet per second of water equivalent to .845 gallons per second or for the one hour 3,042 gallons, or at the rate in a family of four of 760 gallons per day, a requirement for this purpose of 7.6 times the amount of water ordinarily allowed per person in an American family or about 15 times the amount of water necessary to meet their requirements.

Again this water could not all be drawn in one hour and the charging of storage batteries would be done spasmodically as the water was drawn. Again there would be losses of efficiency in the generator, storage batteries and wiring so that the probable requirement of water to furnish the one kilowatt hour would be at least double the above amount, coming to 1,500 gallons or more per person a day.

4. Let us see what the consumption would cost us in order to obtain one kilowatt hour called for by the statement in 3. Assume as in problem three that the requirement for a family of four is one kilowatt hour, requiring about 3,000 gallons per day for its manufacture, making no allowances for losses of efficiency in generator, storage batteries and wiring. In the City of Lewiston, Maine, where water is furnished at probably as low a rate as any city in the United States where pumping is resorted to, water is sold at the rate of twelve cents per 1,000 gallons.

Our 3,000 gallons a day then will cost thirty-six cents, whereas in this city one kilowatt hour of electricity for lighting is sold at eight cents per kilowatt hour, so that by this method of obtaining electric power the cost per kilowatt hour will be over four times that at which the same can be purchased from the central station, making no allowances for losses in generator, storage batteries or wiring, and if we include charge of interest and depreciation on the cost of equipment a kilowatt hour will probably cost about eight times the amount at which we can purchase the same here.

The conclusion drawn from any of the answers to the above problems is that what little energy there may be in tap water will continue to be lost.

WALTER H. SAWYER.

Lewiston, Me.

Did Stone Dust Kill the Cliff Dwellers?

To the Editor of the SCIENTIFIC AMERICAN:

Some time ago you printed an article under the above title or at least on the above topic, which I read with extreme interest. Living as I do in the land of the Cliff Dwellers and about twenty miles from the Aztec ruins, I have been interested in the subject for years.

Those who have observed Indians at their work and who have noticed the deliberate leisurely way they go about it, can hardly agree with Mr. Hoffman's theory.

Making arrowheads and other articles which they used could hardly have caused dust enough to do harm, and while there is a great accumulation of dust in the ruins at the present day, it is likely that when they were occupied the floors were kept damp by sprinkling, as the earthen floors in Mexican houses are kept moist today.

In concluding his article, Mr. Hoffman touches upon what I think was the real reason of the disappearance of the Cliff Dwellers, namely starvation.

We know that they were an agricultural people and farmed the mesas of the region, but what farming it must have been! They kept no domestic animals; if there had been any on the continent then, it would have been impossible to keep them in the cliff houses and they could not have been left below a prey of those who at times attacked them. Imagine farmers of today putting in their crops with no beasts to pull tillage implements. With no tools of metal of any kind whatever. Imagine farmers dropping a few kernels of corn on the ground and punching them in with a flat-topped stick, as the Pueblo Indians were doing up until a few years ago. Imagine the farmer cultivating the crop with a hoe made of the shoulder-blade of a deer, tied to a stick with thongs.

How long could we grow crops in this fashion? Possibly they selected their seed much as the Mexican "ranchers" selected his bulls; leaving every seventh male calf entire regardless of "race, color, or previous condition of servitude."

The ancient dwellers in the ruins at Aztec had a large canal which evidently was used for irrigation, but the land under it, until the whites grew alfalfa and manured it, was about the hardest prospect that man ever undertook to farm. Now it will raise anything that will grow in this climate. The former owners simply farmed themselves out of a job, first depleting the land nearest them, then farther and farther out. Perhaps these out posts became difficult to hold as their numbers were reduced and a year or two of crop failure would end the story; a good deal simpler than dust-induced tuberculosis.

JOHN R. BRYCE.

Durango, Col.

Mechanical Engineering Notes

Survey of Progress in the Mechanical Arts Gathered from Various Sources

The Schoop Process has been steadily developed abroad, and one begins to wonder why we have not paid more attention to this ingenious system of spraying metals. The Schoop pistol is now being used even for galvanizing various outdoor equipment, while its uses for coating objects with copper and other metals have steadily increased.

Rivet-Cutting Gun Abroad—The rivet-cutting gun, which has been in use in this country for some length of time, has recently made its debut in Europe. This device is a great time saver. A cold rivet 1½ inches in diameter may be cut in 30 seconds. ¾ inch rivet may be cut with three or four strokes of the gun. Indeed, with this tool, three men, in nine hours' time, can cut more than 3,000 rivets.

Expediting Marks—One blow of the hammer on one of the new holders of steel stamps does what it would require several operations to do with individual stamps. This is the speedy, accurate, labor-saving way to do interchangeable marking with less effort on all metal products. No matter whether one is doing light marking, such as numbering plates and small parts, or analysis and heat code on hot billets and slabs, there is a holder available for the work.

Rapid Cleaning of Aluminum—There has recently been introduced a new material for the cleaning of aluminum parts. The old method of removing polishing oil and emery consisted of hand brushing the parts with high grade gasoline that cost 35 cents per gallon. The present method is not to do any hand brushing, but to wash the parts in a solution which costs only two cents a gallon. Fire risk is eliminated, work comes through in perfect shape, and a marked economy is effected in the cost of materials and labor.

A Severe Vise Test—An American manufacturer of vises has an interesting and quite convincing test to demonstrate the accuracy of his products. He claims that his vices are so carefully machined and assembled that when two steel balls of equal size are placed in the vise the minimum compression required to hold one ball will be just enough to hold the other. This is true of practically all vises made by this manufacturer, and for this reason his vises hold the work firmly and tightly with less pressure and with less stress on the jaws and screw. Workmen will exert less effort in setting and releasing such vises, it goes almost without saying.

Reversing Gears for Locomotives is one of the recent refinements which are steadily gaining ground. To anyone it must be obvious that the reversing of a powerful locomotive by the manual method must be a strenuous task, especially when it has to be repeated many times in the course of even so short an interval as an hour. This is often the case in switching and yard work, and the tiring of the engine crew accounts for a considerable loss of time, especially over a period of many hours. The reversing gear is a steam-operated device which operates the reverse gear by the mere manipulation of a valve. Thus the engine may be instantly reversed with virtually no physical effort, and much time is saved in consequence.

Speedings of Grinding Wheels—In general, a soft grinding wheel revolving rapidly permits a higher production than a hard wheel revolving more slowly, states a recent issue of *Grits and Grinds*. This is true because the more open structure of the soft wheels provides greater clearance for the grinding chips, which results in a freer and cooler cutting action. Theoretically, therefore, the correct speed for grinding wheels is the safe maximum speed at which the wheel may be operated. In actual practice, however, certain ranges of peripheral speed may be found to give good results on certain classes of work. For example, a satisfactory wheel speed for sharpening wood-planer knives is around 3,500 surface feet per minute; for cylindrical grinding of crankshaft pins and bearings, around 6000 surface feet per minute; and for cutting off hardened and high-speed steel tubing, and the like, the proper speed approximates 9,000 to 10,000 surface feet per minute. The following conclusions are reached regarding grinding operations:

1. The grade of hardness to be recommended for a grinding operation depends on the surface speed of the wheel. 2. The grinding wheel should be as soft as is feasible for the operation, and whenever possible operated at the high end of the recommended range of speeds. 3. For a given wheel used for precision grinding operations, not much increase in production is to be expected from increasing the speed of the wheel alone. 4. The logical way to increase production in precision grinding operations is to increase the traverse of the work past the wheel or the depth of cut of the wheel.

The Maag System of Gear Cutting, developed in Switzerland, is attracting no little attention in Europe. The wheel blank in the Maag machine is mounted on a vertical axis. The movement of the cross-slide during the generating movement is effected by an auxiliary screw, which keeps the slide in uniform contact with the flank of the main pitch screw. It is claimed that this system eliminates all play and backlash. On the Maag system the wheels can be formed of a mild or nickel steel and case-hardened and ground after being cut. In conjunction with the Maag gear cutter there has been developed a generating grinding machine which presents some novel features. The wheel to be ground is mounted on a longitudinal axis and is fed in that direction beneath two saucer-shaped grinding wheels inclined at the same angle as the teeth of the rack cutter. By an ingenious mechanism combining a reciprocating and a rocking motion the wheel as it passes beneath the grinding wheels receives the same rack and pinion action as in the cutting machine. An electrical device is fitted to compensate for the wear of the grinding wheels.

Zinc for Automobile Bodies—Zinc sheets are now being used for many automobile parts. In the No. 18 gage and the heavier ones employed the metal possesses all the strength required, while the cost is decidedly less than that of aluminum. It has the further recommendation that it does not rust and cause the enamel to chip off. In supplying large quantities of zinc for making hub caps and other parts of automobiles, an American zinc company realized the need of a joint different from the soldered type, which would possess as much, or more, strength than the metal and which could be polished smooth without losing any of its strength. The company in question was thus led to successful experiments in zinc welding. The edges of two sheets of zinc were cleaned bright and butt-welded, with a strip of the same material to fill in and give strength to the surface. Bending and tensile strength tests of the joint after it had been polished smooth showed that the two sheets were completely united, and that when thus joined together they were fully as strong at the point as at any other place. The work was done with the oxy-hydrogen flame of a lead-burner's outfit by two men, who, it is stated, were not especially expert either in soldering or in lead-burning.

The Odontometer and the Testing of Gear Teeth—It has remained for a well-known American tool-making concern to develop a practical instrument known as the odontometer for the testing of gear teeth. This device is equally adaptable to spur and helical gears, is fully self-contained, has a range of from 3 to 10 diametral pitch, may be used to check any pressure angle, and can be applied to a gear while it is in place in the machine. An instrument of larger size is now under way for testing the teeth of gears ranging from ¾ to 4 diametral pitch. The odontometer, as used to test spur gears, is composed of a section of a straight-sided rack with two parallel effective faces, one being fixed and the other movable. A third face, set at an angle to the two working faces, is used to hold the fixed working face in contact with the flank of the gear tooth. A registering member is included, which gives direct readings. In general, the instrument is used as a comparator, to test the uniformity of interchangeable and mating gears. If actual measurements are required, the distance between the two parallel working faces of the instrument can be measured. Then, if a record is kept of the variation on each tooth, the value of this measurement between the parallel faces, multiplied by the number of teeth in the gear, corrected in accordance with the variations on the successive teeth, will give the circumference of the actual base circle of the involutes.

Standardized Machine Parts—An important saving can be effected in machine shop practice by extending the standardization of machine tool parts. If it were possible, for example, for lathe manufacturers to agree upon certain standards for toolposts, face plates, spindle noses, and other parts, this standardization would result in considerable economies in all shops where machine tools are used. It would be comparatively easy to arrive at some common standard for T-slots for machines of similar type and size, continues *Machinery*. Another important extension of standardization concerns the motor builder rather than the machine tool builder. Motor manufacturers have not as yet been able to agree upon such standard dimensions for electric motors as will enable the manufacturer to place any make of motor of a given size and for a given current on his machine, without special provision for it. The motor manufacturers have made great progress in standardizing the electrical details, but apparently they do not yet fully appreciate the value of what may be called "mechanical standardization." By cooperation the motor manufacturers could agree upon certain frame designs that would place the shaft for the pulley at a given height above the support. The location of bolt holes should also be uniform, and the shaft diameter should be standardization so that the same pulley will fit on any motor of the same size and for the same current, irrespective of the make.

Miscellaneous Notes

School for Hotel Men.—Belgium will establish a National School of Hotel Management in Brussels. The school takes the form of a model hotel.

U. S. Grant Centenary Coins.—It is proposed that 200,000 gold dollars be coined to celebrate the centenary, this coming April, of Grant's birth.

Essen Turns to War Material.—Through Berlin we learn that Krupp's is resuming the manufacture of munitions, and that Machine Section No. 2 has three howitzers under construction.

Thunder Restores Speech.—When a thunderstorm shook the ship on which he was traveling, C. Lavier, a veteran dumb for nine months from shell shock, found he could talk.

The "Truth-in-Fabric" Bill.—Retail clothiers and wool growers are backing the French-Capper bill, providing for the marking of wool-content on goods. The unrestricted use of shoddy is materially affecting the sheep-growing industry.

Our Trade in India.—Recent experiments in selling American goods in India seem to indicate that, contrary to popular belief, quality, delivery and superior design often win over low prices, especially in industrial machinery and equipment.

The Dover Patrol Memorial on the Dover cliffs is an obelisk 84 feet high, tapering from a base 21 feet square, and built of 700 tons of Norwegian granite. It has a duplicate across the Channel, near Calais.

Japan Reassures Our Candy Makers.—The manager of the Morinaga Confectionery Company, Tokio, brands as ridiculous the report that the American candy market is to be flooded by Japan. He says that sugar costs them about 6 cents a pound, and that the ocean freight rates make export to America impossible.

"One-Age" Companies at Plattsburg.—At the Citizens' Military Training Camp, a new plan groups the rookies by age instead of by their home towns; this will yield light upon what age most quickly produces the trained soldier and which shows the greatest physical improvement in a given time. The plan may have far-reaching effects.

Films of the Western Front.—England's Imperial War Museum has more than 600 separate films covering all aspects of the war on the western front and about every event in the war life of a soldier. A small exhibition room and storage vaults in the War Office are given over to these films, and all are to be carefully inspected to determine which are worthy of permanent preservation.

An Ingenious Fraud.—A Paris mail order dealer objected to the raise in postal rates; so, in sending out stamped envelopes for reply, he covered the stamps with a thin layer of mucilage. When these came back, he sponged off the cancellation mark and used the stamps over again. Unfortunately for him, postal detectives discovered the ruse and he was fined 2,000 francs after successfully working the scheme in more than 10,000 instances.

Our Niagara of News.—From the presses of the United States flow eleven and a quarter billion copies of daily newspapers annually. Census statistics show that in 1919 we had 2,433 dailies that together issued 32,735,937 copies a day, a 18.8 per cent. increase over 1914, while our 592 Sunday papers showed a 14.9 per cent. increase. All products of the printing and publishing industry in 1919 are valued at $1,528,856,503; toward this total, newspapers contribute $612,718,515.

Where the Jinrickshaw Came From.—The jinrickshaw is a part of our mental picture of Japan; it seems to fit in with the age and queerness of this picturesque land. Yet a Philadelphia preacher invented this horseless carriage less than a hundred years ago, and the wheeled chairs of Atlantic City are much older. The clergyman reached Japan with Commodore Perry's fleet and was asked by the Mikado to suggest some vehicle fitted for use in the imperial parks. That is the authentic story of the birth of the jinrickshaw; and the name is a combination of three Japanese words which, literally translated, mean "man-power-cart."

Helium and the Dirigible Disaster.—Wherever the initial blame may be placed for the loss of the "ZR-2," one error should not be repeated; that is the use of hydrogen gas as a filler. Some time ago we were turning out helium at 10 cents a cubic foot; at the time of the Armistice we were building plants to produce 50,000 cubic feet a day, a huge stride toward safety in ballooning. The preservation of lives valuable to their country, to say nothing of the common sense of safeguarding a two-million-dollar piece of property, should urge the resurgence of our helium plants, and the lowering of the cost of this non-inflammable gas as fast as science can accomplish it.

Revolutionary Mail Machine.—There is now in use in New York a machine that, instead of using glued stamps, prints an equivalent postal notice on envelopes at the rate of 250 a minute, thus saving an enormous amount of time and preventing loss of stamps by theft. The machine was perfected after 14 years of experimentation, and Congress has authorized its use. An additional device, which may be operated separately, seals the letters; both may be worked simultaneously by a one-fourth horsepower motor attached to a common light socket. The lessee carries his dialed meter to the post office, where it is set for the amount of postage desired and the money paid in advance. Both the business office and the post office benefit largely. Applications may be made through local offices for the necessary permit from Washington.

Electrical Notes

Summaries and Excerpts from Current Periodicals

Swordfish Hunted With Electricity.—Electrocution is now the approved mode of landing the swordfish off No Man's Land, Mass. A seventy-five-pound specimen was recently taken by sending an electric current through the steel harpoon.

Osiris Prize Award.—Gen. Ferrie, C.M.G., has received the Osiris prize of 100,000 francs in recognition of his war services. He initiated the whole radio organization, equipped the Eiffel Tower station, and did much to bring the thermionic valve into practical use.

Farm Lighting Sets for Britain.—A little judicious publicity work should make England a good market for our farm lighting sets; she has now but a thousand of these equipments, many of them obsolete. Of course, the conservatism of the farmers is the stumbling-block.

California's Hydroelectric System.—Stone and Webster, Inc., recently exhibited at Boston a moving picture illustrating their hydroelectric installment in the Cascade Mountains. The impulse wheels, the largest in existence, each generate 30,000 horsepower. This plant saves the State a million gallons of fuel a year.

New X-Ray Plate.—A plate "reducing exposure to one-twenty-fifth," especially applicable to radiometallurgy, has been produced in England. High sensitiveness is obtained by incorporating the intensifying screen with the plate. After exposure the screen is dissolved off, and development carried out for somewhat longer than usual.

Berlin and the Trackless Trolley Idea—The high cost of track-laying and electrical equipment has given the trackless trolley a favorable hearing in Germany, as well as elsewhere. We learn from a recent dispatch that Berlin is about to try the trackless trolley as a possible solution for financing the street railways of that metropolis. Another Berlin plan is to use one-man trolley cars in the suburbs, just as is being done here in America, in order to reduce operating costs.

Electroculture Formulae.—In electroculture, a series of parallel high potential wires are placed horizontally above the crop. The number of wires being limited, it is a question how far uniform may be the electric force at the ground level. Dr. Chree has evolved simple, practical formulae showing how the potential gradient at the surface of zero potential depends on the height and spacing of the wires. This will make it possible to secure a uniform set of conditions from which more accurate conclusions can be deduced.

Trenton's New Sign—The municipal electric sign, "Trenton Makes—the World Takes," located on the bridge over the Delaware River, Trenton, N. J., is again being illuminated after being dark for a number of months. The Chamber of Commerce has secured subscriptions from local manufacturers and business interests to insure continuous operation for some time to come. The sign is said to be one of the largest electric displays of its kind in the world, being 450 feet long, with letters 12 feet high, and containing about 2,000 electric lamps.

A British World-Wide Radio System has been started, so we learn from a London dispatch. The first link has been completed at Leafield, Oxfordshire, for communication with stations at Cairo, in East Africa, and in South Africa. Another branch of this service will extend to India, Singapore, Australia and Hongkong. It is reported that the scheme also contemplates a newspaper service to New York. The Dominion Premiers are heartily in favor of the new plan, which is to bind the British Empire together with an invisible yet unbreakable chain of communication.

A New Railroad Development, which is apparently electrical in nature, is reported from England. The London and North-Western Railway are experimenting with a new type of engine which is claimed to be far in advance of the present steam type. An electric turbine will take the place of the present motive power, so states the telegram. This, we presume, means that the engine is to include a steam-electric turbine outfit, the current of which is to be applied to a series of driving motors. In addition to attaining a much higher velocity, it is stated that the running cost will be considerably reduced.

Prizes for Electric Suggestions—The local government of the Province of Liege, Belgium, have been closely considering how best to reorganize their existing and projected generated stations in order that the electrification of the province may be most advantageously effected. In order to assist them in the solution of this problem they are offering four prizes, one of 25,000 francs, one of 15,000 francs and two of 10,000 francs, for the four best schemes which may be submitted on or before March 1st, 1922. Full conditions as to this competition and details of the present position of electricity supply in the province may be obtained from the Governor.

An Electric Distiller to provide distilled water for various uses has been developed in England. This device consists of three superimposed compartments. The water is boiled in the bottom one, condensed in the top one, and caught in a distilled condition in the middle compartment, which is provided with a draw-off. The condensing compartment has a domed cooling-water jacket, a ¾-inch cold-water inlet at the bottom and a 1-inch screwed boss at the top, which serves as an overflow outlet for the cooling water. The distiller is made of solid copper with tinned interior surfaces, gunmetal handles and brass fittings. There are no coils for fur or lime to accumulate in, and the hardest water is quite easily dealt with.

A New Design for Resistance Units has made its appearance in England, for which several special advantages are claimed. 1. The new resistance units have a very large radiating surface for a given capacity. 2. Small weight for a given capacity. 3. Absolute freedom for expansion. 4. Owing to the large surface and small bulk of metal, they cool very quickly. 5. They are absolutely unaffected by vibrations or jolts. 6. Units can be run red hot without danger of sagging. 7. Repairs can be effected on separate units. 8. Tappings can be taken off anywhere along the center clamp. 9. The number of units being small compared with a grid resistance of equal capacity, there are not many joints to cause trouble.

Wire Gage by Memory.—Some easily remembered properties of the B. & S. wire gage are pointed out by *Power*. (1) A No. 10 wire has a diameter of 1/10 inch and a resistance of 1 ohm per 1,000 feet. (2) Increasing the wire size three numbers doubles the circular mils and halves the resistance, or decreasing it three numbers halves the circular mils and doubles the resistance. To find size and resistance per 1,000 feet of a No. 1 cable: The diameter of a No. 10 wire is 1/10 inches (100 mils), and therefore an area of 100x100 or 10,000 circ. mils; hence No. 7 would be 20,000; No. 4, 40,000; and No. 1, 80,000 circ. mils. Resistance for the conductors is: No. 10, 1 ohm; No. 7, ½ ohm; No. 4, ¼ ohm; and No. 1, ⅛ ohm. These properties and approximations help greatly in memorizing.

A New Photo-Electric Cell—At the spring meeting of the American Electro-Chemical Society, B. S. Cushman, of Auburn, N. Y., presented a paper by T. W. Case on a photo-electric effect in audion bulbs of the oxide-coated filament type. Mr. Case reported that he had been able continuously to record daylight intensity for several months past. The photo-electric effect on barium and strontium filaments in audion bulbs furnishes a current of 100 to 150 micro-amperes, which actuates an automatic recorder. Mr. Cushman showed two strontium cells, and reproduced on the screen a number of daylight records which had been automatically registered by a Leeds and Northrup potentiometer. One of the cells had almost the same sensitivity as that of the human eye to light. The barium cells are sensitive to the longer rays, the strontium cell to the shorter rays.

Transatlantic Amateur Radio Tests are to be conducted between this country and England and France next December, under the auspices of the American Radio Relay League. The tests will be made between December 8th and 17th. They will be preceded by an elimination test among the larger Eastern amateur stations, which are best equipped for such unusual work. Kenneth B. Warner, Secretary of the League, informs us that the amateur stations in England and France already are preparing for the December experiments, which, if successful, will probably result in permanent amateur communication routes, with several of the more powerful stations relaying messages abroad. Attempts to establish regular amateur radio communication across the Atlantic were made last February, but were not successful. It must be borne in mind that the amateurs are limited in the power and wave length which they can employ, and that a distance of some 3,000 miles is no mean one to achieve with such handicaps. Nothing short of ultra-efficiency can permit a relatively weak transmitter to reach across the ocean.

France's High-Tension Distribution Plans—It is proposed to develop to the fullest extent the water-power resources of France and to construct large steam stations at or near the coal mines to consume refuse coal, so we learn from *Power*. This energy will be transmitted at 150,000 volts to the large industrial centers. The total amount of energy estimated available would be about 4,500,000 kilowatts, 3 millions water power and 1.5 millions steam. The outstanding features of the plan are as follows: 1.—Those plants located close together will be interconnected and their output transmitted to the points of utilization. There is to be no interconnection between different transmission lines at the receiving end, however, in order to avoid troubles in voltage control and to safeguard the individual rights of distributing companies. If the power demand in any one center is of such magnitude that it must be supplied from several sources simultaneously, these sources will not be paralleled but kept entirely separate, and the consumers will be divided up between them. 2.—It is further proposed to store off-peak energy in the steam plants by heating and storing feed water for use during the peaks.

Miscellaneous Notes

Rivalry in the Toy Market.—The Japan Toy Company have had to discharge many employees; German competition is blamed for the dwindling demand for Japanese toys.

High Cost of Clothing.—In England a suit has been sold for £25,000. It is a suit of armor made by Jacob the Armorer for the second Earl of Pembroke, and it was bid up to this figure at an auction sale.

"Treat it with Respect."—This is how the Department of Agriculture warns farmers to whom they are giving 12,500,000 pounds of salvaged war explosives for land clearing. This material is designated as "comparatively safe."

Scars of War are Disappearing.—It will soon be hard to trace the famous front line of the great war. New trees are springing up in place of those blown to pieces, and the unheaved subsoil is transforming itself into verdured stretches.

School for Ships' Surgeons.—The Broad Street Hospital purposes to establish a graduate school for ships' doctors; it will instruct them in all recent developments, especially those pertaining to tropical fevers, leprosy, and other exotic diseases.

Immigration Research.—It is proposed to create a permanent commission to assist the International Labor Bureau. This commission would devote its energies to studying the movements of peoples between various countries, and to important related questions.

Historical Sentiment in the Discard.—The proposal to sell the historic meadow where the barons forced King John to sign Magna Charta loosed an impassioned protest in the House of Lords, and the property was finally withdrawn—after there were no bidders.

New Air Mail Route.—The contract is for delivery of mails by seaplane between Seattle and Vancouver, B. C., with not more than ten round trips a month, to connect with incoming and outgoing steamers. The compensation is fixed at $200 a round trip.

Indians Improve Living Conditions.—Indians under Government control were allowed $562,872 in the first six months of 1921 for farm improvements, including 150 new houses and 68 barns. Modern bathtubs, player-pianos and electric lights are to be found among these Indians.

Home of the Siren Sold.—The famous rock of the Lorelei, on the Rhine, has been purchased by an athletic club, with the object of safeguarding it from disfigurement and from usages out of keeping with its historic surroundings. The rock is distinguished by a remarkable echo.

Why Panama Hats Are Expensive.—The Panama hat, which, by the way, usually comes from Ecuador, is made from the leaves of a small palm. These are cut as they are about to unfold, the veins taken out, and the rest dipped in boiling water tinged with lemon juice. The weaving must be done when the humidity is greatest; an ordinary hat is completed in a week, but one of the first quality may take six weeks. Those of Monte Cristo surpass all others in fineness and lightness.

Posterity to Hear Caruso.—It will be consoling to all music lovers to learn that about 200 different selections as sung by Caruso will be available for future ages. The metal matrices, kept with the greatest care, can be used to make millions of records without appreciable deterioration. At his death there were more than 20 new records still to be released. Caruso was singing for phonographic reproduction for 20 years, and his total income from this source is estimated to have been $1,500,000. The royalty has long been 10 per cent. of the catalogue price, and this will go to his heirs as long as his records are sold. When he died, his contract, made in 1911, had still 14 years to run.

Picture Hanging Without Wire.—Kelvin's five-point principle has been applied to picture hanging. Black-enamelled electric conduit tubing makes a good rail, which is supported on brackets fixed to the wall at the desired height. Two bent iron hooks fastened to the upper edge of the picture frame engage this rail. The fifth point of contact is provided by a round-headed screw upon which the lower edge of the frame rests, to set the face of the picture at the right cant. This leaves the picture a degree of freedom sideways. With this method of hanging, a picture can be removed from the wall instantly, an important consideration in case of fire. The same principle may be used for the support of apparatus in a physical laboratory.

The Renaissance of the Bath.—The Romans were inveterate tubbers; indeed even now some of us vaguely connect this habit with the fall of Rome. Then came a long period when civilization rejected the bath. The first bathtub used in America was designed by Adam Thompson in 1842, and press, pulpit, medicine and the public united in condemning this innovation. Philadelphia seriously considered making bathing illegal between November 1st and March 15th. Virginia laid a tax of $30 on every tub, while Boston actually made bathing unlawful except on advice of a physician. Then, in 1851, President Fillmore installed a bathtub in the White House, and made its use fashionable. Now our hotels boast of a bath to every room, and the compulsory bath menaces those peripatetic philosophers who, in their pursuit of the simple life, place the tub in the same category with manual labor.

Special Starrett Micrometer with Cut Out Frame Now Made with Metric Calibrations

Machinists are often called up to measure dimensions of parts so located that the ordinary micrometer frame cannot be inserted to take the measurement. The Starrett No. 230 one-inch micrometer, having a frame so cut down that it can readily be used in places where the usual micrometer frame will not go, is especially designed to meet such requirements. Until recently this tool has been produced only in English measure. In response to urgent and continued demand, however, The L. S. Starrett Company has recently placed upon the market a similar tool—Starrett Micrometer Calipers No. 230-M—calibrated in metric measure and having a capacity of 25 millimeters by hundredths of a millimeter. The width of the anvil end of the frame is approximately 11/32nds of an inch. The micrometer is equipped with both the Starrett lock nut and ratchet stop devices and is described and illustrated in the new Starrett Catalog No. 22 "B".

Starrett Adds to Line of Caliper Heads

It frequently happens in metal-working shops that none of the commercial ready-made measuring tools or gages available are well adapted to the requirements of some special job. For such purposes special fixtures are made to meet the occasion. To provide such fixtures with a required degree of adjustability of measurement a *micrometer caliper head* is frequently incorporated in its structure. By such an arrangement the fixture becomes an instrument of precision with which accurate measurements can be taken of any dimension varying within the range of the caliper head used.

Until recently the Starrett line of micrometer caliper heads comprised only caliper heads of one inch, or 25 millimeter sizes. Lately, however, The L. S. Starrett Company has produced a new series of caliper heads in the half inch and 13 millimeter sizes.

No. 463 is graduated to read by thousandths of an inch up to one-half inch. No. 464 is similar in capacity but is graduated for measurement by ten-thousandths of an inch. No. 463-M is the same as No. 463 except that it is calibrated in metric measure, being graduated by hundredths of a millimeter up to thirteen millimeters.

These new caliper heads, No. 463, 463-M and 464, are described and illustrated on page 162 of the new Starrett Catalog No. 22 "B", published by The L. S. Starrett Company, at Athol, Mass.

Science Notes

A Digest of Everything of General Interest Appearing in Current Literature

Discriminating Snakes.—Natives of Liberia rub garlic on their feet, finding that venomous reptiles run from the odor.

Llamas in Patagonia.—It is reported from Buenos Ayres that 3,000,000,000 guanacos, or wild llamas, range the pampas of nothern Patagonia.

Millions of Fish Die.—Hot weather and little wind combined to cut off the supply of oxygen from Wisconsin lakes, resulting in an alarming mortality among the finned population.

The Thyroid Gland as Scapegoat.—In New York a woman burglar declared her glands made her do it; a physician testified that her disease, hyperthyroidism, gives rise to criminal tendencies.

Dr. Joel Asaph Allen, Professor Emeritus of the Department of Biology at the American Museum of National History, died August 29 at Cornwall-on-Hudson, aged 83.

To Excavate Armageddon.—John D. Rockefeller, Jr., has given $60,000 to enable the University of Chicago to excavate on the site of Armageddon, where the first battle known to history was fought.

The Origin of Granite.—American scientists plan an expedition to South Africa for the study of unusual geological formations north of Pretoria; it is hoped to shed light on the origin of granite, long a perplexing question to the petrologist.

Relics of the "Dragon's Den."—This cave, near Mixnitz, Austria, while being worked for bird lime phosphate, revealed interesting evidences of ancient occupation. Many quartz implements and utensils and human bones have been taken out.

Rome Believes in Thunderbolts.—Rome reports that the Obelisk in the Piazza di San Pietro was slightly damaged by a "thunderbolt," but makes no mention of any fragments of the meteorite having been found.

Tattooing May Be Costly.—Soldiers in Hawaii lose much time in hospital as a result of the tattooing craze. Such sickness is now declared punishable, and pay is stopped for the duration of the disability.

Tire Punctured by Rattler.—Automobilists ran over a rattlesnake near Ferndale, N. Y. In a punctured tire was found a fang one and three-eighths inches in length. The snake measured 5 feet 7 inches and had 17 rattles.

A Letter from Augustus.—In Cyrene, the ancient Greek colony in Africa, has been found on a block of marble the translation of a letter from Augustus on the government and the administration of justice; this will form a basic source for a history of his reign.

Bell's Noisy Youth.—The story goes that Alexander Graham Bell, shouting to a friend over one of the earliest telephones, was nearly ejected by his landlady on complaint of her suffering lodgers. Today we have a telephone to every nine persons in the land.

Exploring the Amazon.—A writer who claims to be familiar with the ground declares that the reported expedition of scientists to Roosevelt's "River of Doubt" country can result in no gain to civilization; that the headwaters of the Amazon are well known; that the "lost trail" has never been lost; and that the great possibilities of the Amazon watershed should be studied by selecting small areas for thorough examination.

A Mansion for Rats.—The Wistar Institute of Philadelphia is building a $30,000 home for rats. There will be an office, a laboratory, a rat gymnasium, and everything the rodent heart could wish for. The object is observation and experiment, particularly in the direction of food research.

Airplanes as Picture Palaces.—Is air travel already wearying us, and becoming as an old song? At the Chicago Pageant of Progress the 11-passenger hydroplane "Santa Maria" carried an operator and a suitcase projector, to beguile the tedium of flying with motion pictures while hydroplane and audience were hurtling through the air at 80 miles an hour.

Crossing of Species.—An attempt to cross inter-species of the tobacco plant *Nicotiana* resulted in 20 fertilization out of 911 flowers experimented with. Of 19 combinations, says *Science*, only four proved fertile in both crossings and reciprocals, and 4 were fertile in one way only, while 11 were infertile. No plants have ever been obtained from the seeds.

Concerning the Bee.—A recent discovery reveals that the oldest known bees are from Baltic amber (Oligocene Tertiary), and that other Hymenopterous insects, such as wasps, ants, etc., are from the Eocene. From the appearance of the Hymenoptera in the Eocene it is supposed that this group had its appearance in the Cretaceous.

Farewell to the Toy Balloon.—If a gay-colored toy balloon, straining bravely at its tether, doesn't give you a thrill, you may be sure that mental old age has overtaken you; enjoy the thrill while you may, for the Bureau of Combustibles of the New York Fire Department is preparing to banish the toy gas balloon. One child in the city has already died from inhaling the flames from a balloon that ignited from an open gas jet. When Jersey City officials experimented by holding a lighted match ten inches from one of these painted bubbles of hydrogen gas, it burst, igniting the gas. They have already forbidden the jitneys that run to and from amusement parks to fly balloons as decorations. The authorities are loath to deprive the children of their pleasure, but they regard the menace as serious.

Survey of Yellowstone Animals.—Edmund Heller, who was with Roosevelt in Africa, is making a study of the distribution of the deer, bison, grizzlies, antelopes and other wild inhabitants of the Yellowstone National Park. It will be the first comprehensive survey by a naturalist . He will "seek personal acquaintance with the leading local characters and get their own private histories."

The American Chameleon.—We learn from *Aquatic Life* that the color changes of the common chameleon *Anolis carolinensis* are neither so varied as is popularly supposed, nor is there a pronounced tendency, or even ability, to stimulate the colors of its surroundings. As the American chameleon is not a true chameleon it is obvious that the connotation of its false name is not impaired.

A Monument to Stone's Memory.—Dr. W. E. Stone, president of Purdue University and an ardent mountaineer, met his death in the Canadian Rockies after being the first to accomplish the ascent of Mt. Eanon. At the point where he fell, 10,800 feet above sea level, his friends have erected a monument of loose stones, and a flask set into the mound contains a writing that describes his feat. His wife, who accompanied him on the climb, spent four days on a narrow ledge before being rescued.

A Mammoth Scrap Book.—Every line of war news printed by the *New York Times* from start to finish of the conflict has been clipped, mounted on red-bordered sheets, submitted to a 3-ton pressure to extract moisture, and bound into a consecutive history of more than 200 volumes and 81,242 pages, at a cost of $20,000. We have this war news preserved in as permanent a form as skill can compass; and what is probably the most complete scrap book ever made, is now in the library of Princeton University.

Playthings of Ancient Rome.—In the tomb of a little Roman girl who died nearly two thousand years ago has been found a touching collection of toys. A coin, clasped in her hand was to pay her ferriage across the Styx; her favorite dolls, with their cosmetics, were beside her, with a little tea table and a miniature silver candlestick; there were bright-colored building blocks, a gold filigree brooch and a bracelet, and tablets and a stylus. The collection, in a fine state of presentation, goes to the Berlin Museum.

Music for Mail Clerks.—The early-morning lassitude of the night shift of the Minneapolis post office has been turned to cheerful efficiency by the installation of a phonograph. Carefully-chosen records soothe the nerves and raise the spirits of the workers. Jazz is religiously reserved for the final lap for, as E. A. Purdy, the postmaster, says, he doesn't want the men "juggling and tossing about letters and parcels." The idea was put into practice only after a close psychological study of conditions.

An Extraordinary Story.—Two native girl students in an African mission school, awakened by the squawks of excited fowls, found a 15-foot pyton with its head in the hen-roost, They chopped him in two with an ax. Pyjama-clad Methodist preachers arrived and investigated the snake's interior, to find seven frying-size chickens, a setting hen, and her nine eggs. The eggs, unbroken, were put under another hen, who triumphantly hatched them. Rev. E. H. Richards tells this story and refers to the Bishop of Africa as a corroborating witness.

Ant Bears as Insecticides.—South American ant bears have been imported into the State of Washington by fruit and vegetable growers in an effort to keep down the grasshoppers, melon bugs and aphides that infest the northwestern States. The animals are continuous eaters, and are thriving on their abundant diet. The ant bear is a furred animal about the size of a spaniel, with a ridiculously long, pointed snout. In winter these animals will live in greenhouses, where their sinuous tongues will keep the tender plants clean of insects.

Relics of Abraham's Birthplace.—Many interesting finds have been uncovered near Abraham's birthplace. Among them are hollow heads of copper and iron with eyes of jasper, and with teeth and tongues fastened in with copper wire. There are also two columns unique in the annals of archaeology; the wooden cores have crumbled into dust, but there remain the sheathings of diamond-shaped red, white and blue scales on copper wire. Another find is a relief in copper of two stags attempting to escape from the clutches of a lion-headed eagle, probably symbolizing the ascendency of Legash over lesser towns.

Patents and Trade-Marks

General Principles, Current Comment, and Interesting Decisions

Trade Marks in China—The trade mark situation in China is in a very unsatisfactory state. Until a national registration law is enacted, with the necessary machinery for the enforcement of the registration rights and the prevention of infringements, exporters should not place too much reliance on the protection afforded by a compliance with the present Chinese practice. In addition to following the Chinese procedure, it would be well to see that the trade marks are registered in the countries from which similar goods might be exported to China. Because of the proximity of Japan, it is particularly important that the trade marks be registered in that country, as a further means of protecting the Chinese market.

Holland's Patent Law—Under the new patent law in Holland, provisions are made to obtain information by the Dutch patent office examiners with reference to the art which may be cited by the examiners in patent offices in other countries. When patent applications are filed in Holland, and several other countries, where examinations are made as to the novelty of the invention, the Dutch examiners may obtain copies of the official letters issued by the patent offices in the other countries, and review the art which has been cited during the examinations previously made. This will prevent duplicate searches and lessen the work of the Dutch examiners. Similar provisions might be copied to advantage in the United States patent practice.

New Use of Old Method—As a general proposition it does not require the exercise of the inventive faculty to apply an old method or process used in one art to a similar purpose in another art, where the resulting effect is in principle the same. To this effect the Court of Appeals to the District of Columbia, has recently restated the law *in re Braselton* (273 *F* 759), holding that a process of coating or impregnating shoes with metal, by heating the metal to a liquid and blowing it in the form of a spray by a blast of gas against the parts of the shoe, is not patentable, where the same process had previously been applied in coating metal, paper, fabric, glass, and other substances, as an old process applied to a new use is not patentable when it performs substantially the same function.

Protection Against Foreign Infringer—An American manufacturer can prevent a foreign concern from importing and selling in the United States merchandise bearing labels similar in many respects to those used by the American manufacturer and including a word which clearly infringes the manufacturer's trade mark as follows: He can lay a complaint with the Federal Trade Commission; he can institute a suit in equity for infringement and unfair competition; and if he has a federal trade mark registration he can file a certified copy of the same with the Secretary of the Treasury, together with a number of ordinary copies, and request that these copies be forwarded to the various ports of entry in the United States, with instructions that the merchandise of the foreign company bearing the infringing labels and trade mark, be denied entry into the United States.

Patents in the Balkans—There has been an awakening of industrial life in the Balkans since the Armistice. During the war, the Balkan States were brought into close contact with the most progressive countries industrially. This educational period, although limited to war activities, is now bearing fruit, and we see the growth extending broadly in many industries. Social and industrial growth is the forerunner of new laws. Among the laws which have recently been enacted have been patent laws for the protection of inventions in Greece, Jugo Slavia, and Bulgaria. Until the passage of these laws, it was impossible to protect inventions in Bulgaria, and in Servia, which is included in Jugo Slavia. The new law in Greece provides rules for the grant of patents. Before this law went into effect, inventions could be protected in Greece only by a legislative grant.

Employer and Employee—A question of patent law which arises with great frequency is that of the relative rights and liabilities of employer and employee, where the latter creates an invention during the time of his employment. Is the employer under such circumstances entitled to the invention of the employee, or any interest therein? As a general proposition, in the absence of an expressed agreement to that effect, the employer has no right whatsoever to an invention of his employee. At best, should the employee have devised the invention during the time of his employer, and have reduced it to practise on the time of his employer, or in the place of employment, and with the tools and materials of his employer, the latter may acquire a shopright, *i.e.*, a personal license to continue the use of the invention so created. He does not, however, have any right, title or interest in and to the invention itself, or any letters patent which may be granted and issued therefor.

Novelty in Combination of Old Elements—A recent decision in the United States District Court of the District of Connecticut (*Carnes Artificial Limb Co. vs. Dilworth Arm Co.*, 273 *F* 838), reiterated two well-known principles of patent law. First, that a new combination of old elements may constitute invention—where such combination produces a new result, and secondly, that a patent for a device which is inoperative or fails to accomplish the desired end, is not an anticipation of one which successfully accomplishes it. In its decision the court relied on the rule stated by the Supreme Court of the United States in *Loom Co. vs. Higgins, et al.* 105 *U.S.* 580, where the court said: "Now that it has succeeded, it may seem very plain to anyone that he could have done it as well. This is often the case with inventions of the greatest merit. It may be laid down as a general rule, though perhaps not an invariable one, that if a new combination and arrangement of known elements produces a new and beneficial result, never attained before, it is evidence of invention."

Patent Office Interferences—To the patent lawyer, or the inventor well versed in and familiar with patent practice, the frequent occurrence of Patent Office interferences, *i.e.*, conflicts between co-pending applications for the same invention by different inventors, is not strange, though the uninitiated inventor frequently will regard such a happening with suspicion, and he is prone to believe that the other having the same idea must have obtained it in some improper manner. But it must be remembered that human minds are similar in kind and function, and people will think along similar lines, particularly on matters of public interest and discussion, or in connection with happenings or necessities common to many. The same invention, if it is a more or less obvious one, will be independently created again and again by many individuals, far apart geographically and in point of time. Thus, some years ago there was a Patent Office interference involving fifty and more inventors, each of whom had independently conceived the same invention for the automatic stabilizing of aeroplanes by pendulum devices. These inventors were scattered over the entire country, and included many of the prominent pioneers in the field of aeroplane development, and more particularly the Wright Brothers, Curtiss, Herring and Chanute.

Abandoned Trade Mark—For many years a merchant had been manufacturing a toilet preparation under a certain trade mark which had become well-known throughout the trade. He was notified by a competitor that his trade mark infringed one which the competitor had adopted many years before the date when the merchant adopted his. Upon careful investigation in the trade it was learned that this was true, but that prior to the time when the merchant adopted his trade mark and began to use it, his competitor had closed out his business and discontinued the use of his mark. When the merchant received the warning letter he could not find that his competitor was using the mark or that he sold it with his business.

In this case the facts show that there was an abandonment for a period of some fifteen years by the competitor, and that due to this abandonment he has lost all his trade mark rights. It is true that *intent* to abandon plays a large part in determining whether actual abandonment has taken place, but in cases where the trade mark has not been used for many years, as in that just cited, it is to be presumed that the competitor intended to abandon his mark, and that it was open for appropriation by the public. Under these circumstances the manufacturer would be entitled to exclusive use of the trade mark as against his competitor.

Some Trade Mark Fundamentals—A trade mark can be assigned only in connection with the good will of the business with which it is used, and the assignment must be recorded in the Patent Office within three months of the date thereof; otherwise the assignment is void as against a subsequent purchaser for value, without notice.

The granting of registration of a trade mark does not necessarily confer absolute ownership of the mark upon the registrant. The certificate of registration is, however, prima facie evidence of ownership and will be recognized as such by the courts.

An application for registration of a trade mark must be limited to such goods as are classified in one class by the Patent Office. Separate applications must be filed to cover goods classified in different classes.

A trade mark, to be registrable, and in fact, to be a trade mark, must be used in actual physical association with the goods or upon the packages in which the goods are shipped. Mere reference to a trade mark upon stationery or in advertising matter is not trade mark usage.

A certificate of registration of a trade mark remains in effect for a period of twenty years. At the expiration of that period the registration may be renewed for a like period by complying with the Patent Office requirements. Applications for renewal should be filed during the six months prior to the expiration of the registration. A trade mark lives as long as it is actually used as such, and has no limitation of period as has a patent.

Civil Engineering Notes

Abstracts of Important Recent Papers and Published Articles

A Nice Vacation—The White Star Line has granted facilities to Liverpool University that will give engineering students experience at sea during their vacations.

German Locomotives for Roumania—From Bucharest comes the news that Roumania ordered 200 locomotives from Germany, to be delivered in August.

Italians are Accused—Swiss railway carriages returning from Italy are often found to have been stripped of blinds, seat coverings, leather and even electric fittings.

The Propulsion of Ships—In 1914, 89 per cent of the world's ocean-going tonnage used coal as fuel; in 1921 only 72.3 per cent depended upon coal. Propulsion by the internal combustion engine has increased fourfold.

Keep Tabs on Your Automobile Springs—Once a month motor car springs should be examined and any play taken up by tightening the nuts; a strip of leather put under the clips at the small end of the spring will help.

American Brains in China—Dr. J. A. L. Waddell, an American, is appointed by the Chinese government as one of four advisers to examine designs for the new bridge across the Yellow River.

Hydraulics Has a New Journal—The *Journal of Hydraulics* is a new quarterly issued by Hodder and Stoughton of London to disseminate the details of world developments in hydraulic engineering.

Deterioration of Reinforced Concrete Marine Structures—Two papers were contributed to the conference upon this subject, which is of great importance to the future of reinforced concrete for harbor work.

Replacing the Automobile Cylinder Head—After the cylinder head has once been removed and replaced, it should be tightened up by screwing down opposite nuts a turn or two at a time, working gradually around the head; otherwise there is likelihood of springing the head.

Tunneling Knowledge Sought.—C. M. Holland, chief engineer of the New York-New Jersey vehicular tunnel, has sailed for Europe to study English and German tunnels, particularly the methods of ventilation and the best kind of lining for the tubes.

Palestine's Great Projects—Urged by the shippers of Jaffa, the government of Palestine is to enlarge the ports of Jaffa and Haifa; further projects are the erection of a water-power plant sufficient for all Palestine, the irrigation of the Jordan valley and the building of a railroad from the Sea of Galilee to connect with the Bagdad Railway.

Newcomen's Memorial—Newcomen, the Dartmouth blacksmith who developed the cylinder-and-piston steam engine, has had erected to his memory, in the town of his birth, a memorial consisting of two engraved brass tablets mounted on a large block of rough granite. His first engine was set up near Dudley Castle in 1712, and he knew no rival until Watt appeared.

Simplon Tunnel No. 2—The first Simplon tunnel, begun in 1898, was opened to traffic in 1906. It presented appalling problems, such as the diversion of hot springs and, in one instance, a rock pressure so great that it took 18 months to pierce 50 yards. The second Simplon tunnel was originally drilled as an aeration gallery for the first; the enlargement of this gallery to a full-size tunnel is now practically complete.

Bamboo Reinforcement for Piles—Quantities of concrete piles, reinforced with stripes of bamboo, says *The Engineer*, have been employed with success on the Szwchuan-Hankow Railway, China. The piles are 10 inches by 10 inches by 30 feet long, and are reinforced by four ⅝-inch strips of green bamboo, placed at each corner and wired together with square loops, also of bamboo, placed one foot apart.

Hydro-Electric Course—The University of Grenoble, in France, has for many years made a special feature of instruction in water-power and power transmission. A series of vacation lectures with visits to some of the numerous installations in the neighborhood were held during the past summer. The hydro-electric technical course will in all probability be a regular feature every summer.

American Equipment for French Railways—The Midi Railway of France has placed an order amounting to $1,200,000 for electrical equipment with one of our leading manufacturers. It includes transformers, condensers, lightning arresters and various other equipment for substations. The section on which this equipment will be used has a total length of over 100 miles and extends from Pau to Toulouse, in the Pyrenees Mountains near the Spanish border.

Economic Length of Cantilever Bridge—Writing on the comparative economics of suspension and cantilever bridges, Charles Evan Fowler says that the span of equal costs will probably be found, in comparing cantilever and suspension bridges for any particular case, to hover closely around 1,700 or 1,800 feet. It will vary somewhat with the particular designs compared; thus a wide differ-
fixed towers and one with hinged towers.
ence will be found for a suspension design with

Rumanian Railroad Construction—The program of the Rumanian Ministry of Public Works has provided for the construction of the following railroad lines: Livezeni-Bumbesti, 27 kilometers, to establish direct communication between the coal districts of the Jiu Valley and old Rumania; Brasov-Nehoias, 100 kilometers, to relieve the congestion on the Brasov-Predeal-Ploestie line; and Ilva-Mica-Vatra Dorna, to connect the Transsylvanian system with Moldavia and the Bukowina.

Hydro-Electric Plants in Mexico—For some time Mexican authorities have offered inducements for the establishment of hydro-electric plants in or near the Federal District, the plant of the existing power company being inadequate for the needs of the region. A decree has been issued reducing Federal taxes on the use of water for power and irrigation, and the press announces that two Mexicans have now submitted a proposal for the erection of such a plant.

South African Electrification—The latest reports regarding the proposals for the electrification of certain sections of the Government railways of the Union of South Africa are to the effect that no bids have as yet been accepted, and that it is possible that the program may not be carried through at this time to the full extent planned for. It is reported that uncertain business conditions may influence the Government to defer this work to some extent.

Extemporized Radio Service—To make possible communication between the many camps of a hydro-electric installation in the mountains of California, a novel system of wireless telegraphy was adopted. The antennæ were hung from tall pine trees. Satisfactory communication was obtained at an elevation of 10,000 feet between stations 7 and 15 miles apart. It was found that a continuous wave using a current of 2½ amperes gave better service than a dampened wave of 4 amperes.

At Ancona, the most important seaport of the Rome section of Italy, four berths are ordinarily available at the quay for discharging coal, two of which can accommodate steamers of from seven to eight thousand tons, while the others are capable of handling vessels of from four to five thousand tons. In emergency cases other docks, customarily devoted to loading and unloading general merchandise, can be used for coal. The depth of water alongside docks is 26 feet, and lighters are in hand for unloading vessels of deeper draft.

A Piledriver Extraordinary—What might well be called a piledriver extraordinary is described in the *Engineering News of Record*. Damage by marine borers made it necessary to remove some piles under a wharf at Port Costa, Calif., and a special driver was prepared for this work. It was built up on a pontoon, and had a mast 98 feet high and jib 110 feet long. These dimensions made it possible to reach over the piershed and drop the new piles through small openings made in the roof. Some of the piles were driven at a distance of 90 feet from the water front of the wharf.

Twenty Years' Advance in Locomotives—At a recent meeting of the American Society of Mechanical Engineers, Mr. W. E. Woodward stated that 20 years ago it was considered good practice if seventy horsepower could be developed for every five tons of the weight of a locomotive. Today it is common practice to obtain 100 horsepower for the same weight. The locomotive of today of 3,500 horsepower weighs about 350,000 pounds. If such a locomotive were designed according to the practice in 1905, it would weigh at least 500,000 pounds; it could not be accommodated on railroads; and the boiler would be so large that it could not be properly fired.

The Bearing Power of Soils—A paper on this subject has recently been prepared by Mr. A. L. Bell of the Institution of Civil Engineers. Mr. Bell has already made a valuable contribution to the subject in the 1915 transactions of the Inst.C.E.; his conference paper comprises an interestin historical summary of the subject which will provide a very useful list of preliminary reading for engineers who feel encouraged to attack this important subject. We gather from Mr. Bell's paper that he agrees with the view often expressed, that the principal need of the present is the development of formulæ for practical use which embrace the results of the most recent work upon the subject.

The Port of Paris serves only the city of Paris; its development is interesting. The extensive wharves were at first mainly used to handle incoming food and fuel; the growth of the city made necessary many lateral communication canals; later a third section developed above and below the town to supply outlying factories. Im-

provements are planned that will make Paris accessible to seagoing vessels; a canal from the Marne will lessen the danger from floods and open a direct route to the sea from the Sarre region. Coal and building materials are now three-fourths of the imports, and 85 per cent of outgoing shipments consists of building wreckage and refuse. It is possible the future may see Paris an important transshipping port.

Cement Industry in South Africa—There are but six cement factories in the Union of South Africa and none of them of any great capacity, we learn from *Commerce Reports*. A cement company proposes to erect a plant at Cape Town with a capacity of 500,000 bags of cement annually. The imports of cement during 1920 amounted to 50,717,000 pounds, valued at $582,029 (at normal exchange). During 1920, practically all of the cement came from the United Kingdom, Canada, Belgium and Germany, the United States only furnishing 16,800 pounds. The demand for cement is increasing, and should conditions improve so that the long-delayed housing schemes can be carried out, there will be a considerable demand for imported cement.

Again, the Rhone Project—The Rhone from the Swiss frontier to the sea is capable of supplying power on a large scale, if only its resources were were tapped. It is estimated that if all the French waterways were utilized, 9 million horsepower could be generated, of which the Rhone would furnish 1¾ million horsepower. Plans to create power plants on a large scale were laid down several years ago. As far back as 1902 there was a project to build a station on the upper Rhone capable of generating 200,000 horsepower, which could be transmitted to Paris for lighting purposes at a very cheap rate. The Swiss authorities expressed themselves in complete accord with the scheme, as far as affects the head waters of the river. The first plant would be erected at Genissat, and the second at Chanaz-Perieux. These would trap the whole of the waters between the source and the last-named town.

Impact Allowances for Bridge Design—Mr. H. J. Fereday contributed a paper at the recent meeting of the Institution of Civil Engineers upon this subject, which has exercised the minds of engineers since the days of Fairbairn and Wöhler. It is still a moot point whether the phenomena generally popularly collected under the term "fatigue of metals" require separate treatment in design from those resulting from impact or dynamic action. Mr. Fereday states that, although a large number of experimental investigations have been made upon the actual stresses (or rather strains) caused in bridge members during the passage of a train over the bridge, the results have not been analyzed with sufficient thoroughness to enable a rational formula to be deduced for use in practical design. He suggests that we should first measure upon a given bridge (1) the maximum stresses produced by a live load crawling over the bridge; (2) the corresponding maximum stresses produced by the live load at the highest permissible or critical speeds. If we plot diagrams showing the variations of these stresses along the span, the difference in the two curves will give a measure of the impact effect.

The Tallest Concrete Building—The tallest reinforced concrete building in the United States is one recently erected in New York City. It stands on a site approximately 75 feet square and is eighteen stories high. From the basement to the top of the roof the building measures 223 feet high. Work was begun in October, 1920, and finished early this year. To guard against freezing the concrete was delivered into the molds steaming hot, and the molds were kept sufficiently warm by means of special heaters. As one floor was molded every week, care had to be taken to avoid excessive strains in the green concrete, and five successively completed floors were kept shored during the greater part of the time. The exterior surfaces of the building consist of white Portland cement and colored aggregates, including quartz, feldspar and green stone chips, the lowest stories being finished by bush hammering and the sixteen upper stories by the aid of an electrically driven carborundum grinding machine. The general effect of the surface treatment is said to be excellent. We have asked one of our contributing editors to prepare a story on this novel building, which will appear in an early issue.

Bridge vs. Tunnel for Hudson River—That railway tunnels will usually be cheaper than railway bridges for spans exceeding 2,000 feet when property damages are taken into consideration; that a highway bridge would be cheaper than a highway tunnel even for a 3,000-foot span unless property damages are quite heavy; and that short-span lengths favor a bridge, while long-span lengths favor a tunnel, are some of the facts set forth by Dr. Waddell in a communication to the American Society of Civil Engineers. Dr. Waddell claims that safe ventilation of a tube carrying automobile traffic is as yet an unsolved problem, and he quotes certain authorities to the effect that carbon monoxide even in minute quantities is a cumulative poison which would gradually undermine the health of those constantly using such tunnels. The high temperature (20 deg. Fahr. above outside air allowable by the designers) he believes would cause much discomfort in summer. He states in conclusion that although Mr. Lindenthal's single bridge for many lines of traffic might apparently be cheaper than the equivalent tunnels necessary, when the property damages for long railway approaches are duly considered it would be found cheaper to carry all the railway tracks in tunnels and carry highway traffic by the bridge.

Applied Chemistry Notes

Condensed Information Gathered from Chemical Journals and Other Sources

Adolphe Wurtz Honored.—A monument in memory of the French chemist, Adolphe Wurtz, was unveiled recently at Strasbourg.

Removing Paint and Varnish.—An inventor has just obtained a patent for removing paint and varnish from automobiles with a hot solution of sodium hydrate or other solvent applied with an air blast.

A Fireproof Paint.—A fireproof paint has just been patented consisting of 19 parts of milk, 5 parts sodium tungstate, 10 parts of borax, 10 parts of gum arabic, 20 parts of kaolin, 10 parts zinc white, 10 parts sodium silicate, 6 potassium silicate and 10 parts of feldspar.

A New Cement for Leather.—Two English inventors have patented an adhesive composed of naphtha. The balata dissolved in a solvent like naptha. The balata is cleaned by boiling and rolling into sheets, which are kneaded under steam pressure and then exposed to the solvent.

Increasing the Capacity of Moisture in Bread Dough.—Two inventors have recently secured a patent on the use of calcium peroxide in breadmaking. About .007 per cent of calcium peroxide to the weight of the flour is incorporated in the bread dough to increase the capacity for moisture.

Rich Vein of Copper Found in Shetlands.—A copper vein of great richness has been discovered in the Shetland Islands. The lode was said to have been proved to yield a high percentage of copper. Experts who are erecting a plant at the mine site think that half a million tons of ore are in sight.

Jerusalem Artichoke as a Source of Alcohol.—This tuber is a splendid source of alcohol and is being largely used in Germany; but commercial fermentation of this material is now forbidden in that country. The highest yield was obtained from the raw mash not steamed or treated with malt, but fermented with brewer's yeast.

Stenches for Mine Signals.—The Bureau of Mines has been cooperating with large mining companies in the perfecting of devices to warn miners of danger by means of stenches. A vile-smelling liquid is introduced into the compressed-air line and the odor soon gives its warning through the nose.

Fatal Case of Borax Poisoning.—The medical papers have reported a case where a man of 66 years of age swallowed 60 g. of borax by mistake and death occurred in three hours. Household borax seems to have always been regarded as harmless, but evidently it should be used sparingly where it is liable to get into the system.

Non-Freezing Dynamite.—A very large manufacturer of explosives has just perfected a formula for a non-freezing dynamite which will displace the older type of explosive as far as they are concerned. Thawing, with its attendant dangers, is eliminated. The formula is the result of years of experimentation.

Food From Fish.—The cooked residue from fish oil manufacturing is crushed or ground to a paste, says *Chemical Abstracts*," dried in vacuo at a temperature below 10 per cent, reduced to a powder, treated with a proteolytic enzyme such as pepsin to solubilize the albumin content of the mass, extracted with water and the result thus obtained is dried and powdered for use as a food.

TNT Good for Road Building.—TNT, in the opinion of Thomas H. MacDonald, chief of the Bureau of Public Roads, is a good explosive for use in road construction. Through this bureau 26,000,000 pounds has been distributed for that purpose without an accident. As TNT does not freeze and the fumes do not produce any ill results, it is popular with road builders, both contractors and laborers.

Chlorination by Ultraviolet Light.—Two Japanese inventors have devised an ingenious apparatus consisting of a closed chamber provided with a window having a lens of uviol or quartz glass and two tubes opening at the focus of the lens and another tube for exit of the product. Chlorination is conducted at the opening of the tubes under the influence of ultraviolet light which is sent through the lens.

Palatable Sirup From Sugar Beets.—An edible sirup is prepared by heating sugar beets in water (preferably to a temperature of about 80 degrees), separating the liquid and heating it in an autoclave to a temperature of about 109 degrees (C) for about one hour, and blowing off steam from the autoclave at about fifteen-minute intervals during the heating to eliminate substances of objectionable flavor.

Cheaper Shoes.—The Leather Industries section of the American Chemical Society will discuss the question of producing cheaper shoes at the September meeting. Due to the slowness of present tanning methods, quick turnover of stock is impossible. By a new method the tanning period will be reduced to a minimum, permitting a speedier release of the leather manufacturer's capital. Cheaper leather, and consequently cheaper shoes, are anticipated as a result.

Examination of Sugar Crystals by Projection.—George P. Meade stated before the section of Sugar, Chemistry and Technology of the American Chemical Society that the examination of sugar crystals by projection was feasible. Samples of raw sugar from several factories are classified each day as to size and regularity of crystal. A "balopticon," or similar device, with vertical attachment, throws an image of a small portion of the sample on a screen, magnifying it ten diameters, says *Science*. Squares drawn on the screen correspond in size to an arbitrary scale of ten, and the observer compares the image of the crystals with the squares, determining the size to the nearest whole number of the scale. The projection also shows the regularity and form of the crystals, and abnormalities are noted.

Drying Crystals.—If you require to dry large quantities of chemical crystals it will be necessary to centrifuge them, says J. Cayley Jones in *The English Mechanic*. Small amounts (an ounce or two), however, may be dried by placing them in what is known chemically as a desiccator. This is a glass vessel generally containing a mixture of concentrated sulphuric acid and pumice stone cubes. The vessel is air-tight, and has a support over the acid mixture on which a small dish containing the crystals may be placed. The acid quickly mops up the moisture in the container, and thus dries the crystals, a few days generally sufficing to complete this operation, depending on the nature of the chemical to be dried. Care must be taken when handling the acid as it produces bad burns when in contact with the skin.

A Curious Acid.—Formic acid (*L. Formica*, an an ant) is found in the vegetable and animal kingdoms. If the leaf of a stinging nettle is examined with a microscopic it is seen to be covered with long pointed hairs having a gland at the base. This gland contains formic acid. When the nettle is touched lightly, the fine point of the hair punctures the skin, and a subcutaneous injection of formic acid is made, which quickly raises a blister. The inconvenience which arises from the stings of bees and wasps, also from the fluid ejected by ants when irritated, is due to formic acid. The remedy in each case is the same; the acid must be neutralized as quickly as possible with mild alkali, such as washing soda. Formic acid was first made by distilling an infusion of red ants. It is now made from glycerine and oxalic acid.

Crystals and Water of Crystallization.—When a soluble salt is to be recovered from its solution the latter is reduced in bulk by evaporation until, either by experience or by trial, it becomes evident that the solid will be formed as the liquid cools. In some cases, when time is not an important factor, evaporation is left to take place naturally. Under either set of conditions, the substance generally separates out in particles which have a definite geometrical form. These are spoken of as crystals. Crystals often contain a definite percentage of water, called "water of crystallization." In sodium carbonate, this combined water forms nearly 63 per cent of the total weight; in copper sulphate it is approximately 36 per cent. On being heated to a moderate temperature, the water is expelled from the solid; the substance which is left behind is called the anhydrous (that is, the waterless) salt.

Stones Absorb Water.—Stone is by no means impervious to water. Some kinds, notably coarse sandstones, hold a large percentage. Even marbles absorb considerable quantities. The absorptive capacity of limestone ranges from 7 per cent or more down to practically zero. Porous limestones, in which the pore space ranges from 10 to 15 per cent, will absorb from 4 to 6 per cent of water, whereas semi-crystalline and crystalline limestone or marbles have lower percentages of pore space and of absorption, such marbles as those from Vermont, Tennessee and Georgia being almost non-absorbent. Pumice stone, which is usually lighter than water, owing to its great amount of pore space, will absorb large quantities of water; obsidian and volcanic glass, which are of the same chemical composition as pumice stone, but several times heavier than water, will absorb none. Quartzite, granite, and the numerous eruptive rocks are practically impervious to water.

Carbon Black in 1920.—The total quantity of carbon black produced from natural gas in the United States in 1920 was 51,321,892 pounds, a decrease of 1.4 per cent from 1919, notwithstanding an increase in the number of plants. In 1919 the plants were still operating at or near full capacity on account of the war, but since normal conditions have been restored the production has decreased. The output in 1920 was made by 39 plants, operated by 19 producers. The total value was $4,032,286, as computed from the prices received by the producers. The prices ranged from 4 cents to 27 cents a pound. The average daily production in 1918 was 120,830 pounds; in 1919 it was 144,600 pounds, and in 1920 it was 140,608 pounds. About 40,600,000 cubic feet of natural gas was consumed in the manufacture of carbon black in 1920. In 1920 the production of carbon black per thousand cubic feet of gas consumed ranged from 0.45 to 2 pounds, but the average production during the year for all States was about 1.26 pounds.

Notes and Queries

The Notes and Queries column is maintained for the benefit of our readers who desire information on subjects germane to the scope of the paper, together with technical formulas and similar information. Matters requiring profound research or searches in a library cannot be undertaken. In connection with Notes and Queries proper, we maintain a "Service Bureau," which is able, in nearly all cases to supply addresses of manufacturers whose articles have sufficient novelty and merit to be illustrated in the news pages of this periodical. Correspondents are requested to write their inquiries in all cases, making the subject of the letter entirely separate from the correspondence relating to patents, subscription, books, etc. This will greatly facilitate the answering of these questions, which in many cases have to be referred to experts. The full name and address should always be given. Our full "Hints to Correspondents" will be gladly mailed on request. All letters are answered by mail and only a very few of them can be printed in the limited space at our disposal.

(14363) J. A. M. asks: For information, can you give us the required answer? Is it possible for a horse to pull in any way, shape or form, or does the horse push all the time when drawing a load, when tied, when holding anything with the saddle, when anything is tied to the tail. In fact, is it possible for a horse to pull at any time. I have money that says he can while another party has money that says that it is impossible for a horse to pull. A. Your question is not so simple as it appears to be upon its face. There are various transformations of the forces to be taken into account. The horse pushes with his legs and feet backward against the ground whenever he draws a wagon forward. He also pushes against his breastplate or collar by the same effort. But his push is transformed into a pull in the tugs or traces and this pull it is which moves the load forward. If a rope were attached to the tail of the horse the case is slightly different. The horse pushes with his legs against the ground as before but the push becomes a pull upon the rope which is attached to his tail. In exactly the same sense a man pushes himself forward when he walks or draws a load by a rope and he also pulls the load along. If you see carefully the transformations of the force employed you will see where there is a push and where the push becomes a pull. The answer to the query is that there is at one time a push and again a pull in the case supposed.

(14364) I. M. P. asks: 1. Why does water that has been previously boiled freeze at a higher temperature than water that has never been boiled, and at what temperature will this boiled water freeze? 2. The absolute zero being 461° F. below the ordinary zero F., what is the meaning of this absolute zero? Is it a point where no radiation takes place, or is it the lowest point that can be reached? 3. What causes a "Scotch boiler gage glass" to break when installed and under steam pressure if it has previously been in contact with steel or iron? 4. Explain why the true water level is not shown by the gage glass when the boiler is under steam pressure, and why does the water level rise in the gage glass when the top cock is closed? A. 1. Boiled water is practically air-free, and air-free water will cool faster than water containing air, so that it comes to the freezing point sooner than water which has not been boiled. We have never supposed that air-free water would freeze at a higher temperature than water which contains air. We have never seen any discussion of this matter in a scientific book. Perhaps the scientific men at the Bureau of Standards, Washington, D. C., have some facts on this subject. 2. Absolute zero is the temperature at which all heat has left matter, at which all motion of molecules would cease. It has never been reached. It is the lowest temperature which can ever be reached if the theory is true. 3. We do not know any influence of steel or iron upon glass by mere contact which can make a gage glass break at some future time. The statement does not sound scientific. 4. If either valve of the water-column is closed, the level of the water in the tube will rise. If the top valve is closed, the steam in the upper part of the tube will condense and be replaced by water entering from below. If the lower valve is closed, the condensation of steam in the upper part of the tube will accumulate and gradually fill the tube. If the fire is stirred up under a boiler which has been banked, the water-level rises in the tube, because the circulation is

from the front of the boiler to the rear and this circulation is maintained by a difference of level between the front and rear ends. When a boiler which has been steaming freely is checked the water-level drops.

(14365) F. I. P. asks: My text-books on astronomy do not specify the eleven (I think) motions of the earth; please advise me what they are. A. We have never seen any list of all the motions of the earth. There may be eleven and there may be more. The earth yields to the attraction of every heavenly body around it. We will name a few of its motions but cannot agree to give a complete list: Rotation on its axis; revolution around the sun; motion with the sun as the sun moves through space; motion around the center of gravity of it and the moon; an irregular motion so that the pole moves in the earth; nutation; precession of the equinoxes. Then there are the deviations made by the attraction of Mercury, Venus, Mars, Jupiter and Saturn. These last are very minute. There are doubtless others which we have overlooked. Most of these are given in the larger astronomies, such as Young's Manual.

(14366) G. M. R. asks: Which side of an auto or rather which wheels tend to leave the ground on turning the machine around? Is it the inside or outside pair? What effect does a slow or fast turn have? A. If a car turns a corner too fast it overturns toward the outside of the curve and away from the center of the curve. This will cause the outer wheels to press harder on the ground and the inner wheels to leave the ground. The only difference between going slow or fast around a curve is in the degree of the danger of an overturn. Go slow and you are safe. The outward thrust on the car will not be enough to cause an accident. Go too fast and you can negotiate an overturn every time.

(14367) G. P. B. asks: I have had my attention especially called to the Hertzian Ray Theory and as I am sadly in want of information upon this subject. A. Hertz's work supplied the experimental proof of the Maxwell theory that light is an electromagnetic effect. He demonstrated the existence of electromagnetic waves by means of his resonators. You will find these experiments in any college textbook of physics. Ganot's is good, so too is Carhart's. Hertz's experiments laid the basis for wireless telegraphy and he just missed the discovery of X-rays. He probably would have detected them had he not died at the early age of 37 years. No scientist has been more deeply lamented than he. He was recognized as one of the most promising men of his time. We should not speak of a "Hertzian Ray Theory." We should say the Experiments of Hertz in demonstrating the Maxwell theory. His work, "Electric Waves," was published in England after his death.

(14368) S. C. P. asks: (a) What is the chemical equation (or equations) for the action taking place when (1) chlorine gas is passed through sodium hydroxide solution and (2) when an uncombined mixture of hydrogen and chlorine gases is passed through sodium hydroxide? (b) (1) What are "vinegar bees" and (2) how does their action compare with that of yeast or "mother?" (c) What is the complete explanation of the fact that when crystals of potassium dichromate or blue vitriol, etc., are crushed the color of the pulverized substance is lighter than that of the crystal? (d) Why does the lower surface of a sheet of ice on a pavement melt in the sun before the upper one? (e) (1) In using a resistance or ballast coil in connection with a carbon arc for a projection lantern on a 110-volt circuit, how should it be adjusted to secure the most light without heating the coil? (2) If coil heats, should resistance be increased or decreased? (3) What would be proper specifications for a coil which would operate satisfactorily on such a circuit? A. (a) You will find the reactions for chlorine gas upon sodium hydroxide given in Alex. Smith's Inorganic Chemistry under "Hypochlorites." The book gives the reactions for potassium but of course they are the same for sodium.

Cl_2 + H_2O give HCl + HOCl.

The HCl + KOH give KCl + H_2O.

And the HOCl + KOH give KOCl + H_2O.

If this is reduced to a single equation it is

Cl_2 + 2KOH give KCl + KOCl + H_2O.

Write Na for the K and you have reactions for Na. Both potassium chloride and potassium hypochlorite are formed. The presence of free hydrogen gas would not have any effect. It could not enter into combination with any of the substances in the reactions. (b) "Vinegar bees" are an impure kind of yeast, and like all yeast will produce fermentation and thus produce alcohol. The re-

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sulting drink is not safe nor healthful. (c) The streak or scratch upon many crystals is white because the streak contains air and the air reflects the white light fully. A crack or shiver is apt to show all the colors of the spectrum, as in the opal. Copper sulfate and many other crystals have a white streak when scratched. (d) The sheet of ice on the pavement melts from the lower surface because the stone or asphalt is warmer than the air above the ice. The heat of the sun penetrates the ice easily and without melting the upper surface any more at least than it melts the interior of the ice. The pavement below is heated more easily than ice is melted, and thus becomes warm enough to melt the ice, or to reflect the heat of the sun back into the ice and melt it. Ice on a lake or pond melts throughout its entire thickness in the spring with the heat of the sun and falls into pieces, long prismatic pieces, which then are easily melted in the slightly warmer water. This gives rise to the popular notion that ice sinks in the spring. (e) A coil in series with an arc light in a projection lantern is used to take care of the excess of voltage in the line. An arc requires 45 to 50 volts to force the current across the gap between the carbons. An arc uses about 15 amperes to give a sufficient light for lantern slides. Ohm's law is amperes equals volts divided by ohms. The arc takes 50 volts of the 110. This leaves 65 volts which must be taken care of in the coil. But the 15 amperes flow through the coil also, and the 65 volts divided by the 15 amperes gives 4⅓ ohms for the coil. Now you may want 20 amperes sometimes to light up a very dense slide, and 65 divided by 20 gives 3¼ ohms. So that you would better have a variable rheostat, having from 3 to 5 ohms in 6 sections. Then you can adjust the current to the size of the picture on the screen and the denseness of the slide. With a fixed resistance in the coil you cannot vary the light. Your idea of a coil which will not heat is way off from fact. No wire can carry a current of electricity without heating. Any resistance is heated by a current, else an electric light would be impossible. All the current which flows through the coil is transformed into heat and thus dissipated, gotten rid of, prevented from burning the arc too fast, as would be the case if the whole 110 volts were turned upon the carbons to produce an arc which only requires 50 volts at the most. Your rheostat may be made of No. 12 iron wire. This will stand the heat for a long time before it is rusted out. No. 12 iron wire has about 105 feet to the ohm so that you should have 525 feet of wire in the rheostat. If a coil heats too much its resistance must be increased else it may melt open.

(14369) J. S. L. writes us a very pleasant letter, but complains of the fact that names of manufacturers, etc., are not found in the text of the SCIENTIFIC AMERICAN, and suggests that possibly he would be burdening us with unnecessary correspondence if he should ask for the names. We beg to advise all our correspondents that we maintain a "Service Bureau," which is always pleased to furnish the address, which we are able to supply in practically every instance, and provided the information is asked for by mail. The names of manufacturers, etc., are purposely omitted from the paper, as it has been our policy to keep our columns entirely free from any such matter, so that our reader may always know what he sees in our paper has been prepared by our own editorial department, and is not the product of some publicity agent who is merely trying to sell his merchandise through the medium of a trade write-up.

(14370) T. M. B. says: "I am employed by a company manufacturing machinery and tools and have invented a new tool which I desire to have patented. The tool was invented and perfected at home, but, owing to the lack of necessary machinery I had to do some work during my lunch hour at the factory. The superintendent of my department saw the tool while I was working on it, realized how well it was adapted for use in the factory, and informed me that if I did patent it I would have to turn over all my interests in the invention to the company, as they have a right to anything invented by any of their employees. I have never made any agreement with the company relative to inventions and to my knowledge no such agreement exists. Will you please advise me as to my rights in the matter? I am an old subscriber. A. An employer has absolutely no rights to the inventions or discoveries of his employees unless there is an agreement or a contract to that effect. From such information as you furnish the invention belongs to you and even though you did work on your device at the factory, this would not give the company any rights in the invention.

Tours and Detours

(Continued from page 8)

To reach the west from Wheeling the well-advised motorist will steer clear of the Colerain Pike, which in the road books appears as the choice. Go on to Zanesville and Columbus, and then think of striking north; or if your destination lies in eastern Ohio, turn north for Pittsburgh at the big crossroads a few miles beyond Uniontown—you can't miss it. The objections to the Colerain Pike are, first, the rough surface and the profusion of loose stone; second, the extreme difficulty of staying on it in the face of instructions to "follow the Pike;" and third, the utter impossibility of finding it in the first place. We passed its head twice while looking for it; it never occurred to us that it could be anything but a billy-goat trail up the hill between the back doors of the shanties. But if you can find it and stay on it and if you like sporty hilly going, you will have a good deal of fun with the Colerain Pike.

The other alternative is equally attractive. The Mohawk Trail combined with the Albany Post Road gives a route of unusual merit from New York to Buffalo. Except where it suffers from bad city pavements it is in extremely fine shape throughout; and it is so well marked that I followed it, without any guiding literature, clear from Buffalo to New York, asking the way only once, when I found no other means of locating the bridge at Albany. From Buffalo west along Lake Erie the route is a disappointment in the sense that it follows the Lake closely only here and there; and for 1921 there were three detours of unnecessary length and, in two cases, of poor character. It looked as though these would be lifted by the end of the season, however, and the only one that was really serious was the one west of Erie. From the state line into Cleveland the road is particularly satisfactory. West of Cleveland one can follow the Lake to Sandusky over roads that are in first-class shape save in passing through Huron; and from Sandusky one strikes southward to Bellevue; there rejoining an alternative road from Cleveland via Berea and Oberlin which is likewise in good shape. The wise procedure is then to steer due west through Fremont, Bowling Green, Napoleon, Bryan, Butler, Ind., etc., and join the Lincoln Highway at Goshen. Beyond Fort Wayne stick to the Lincoln Highway; the short cut to Chicago via Warsaw includes a lot of second-rate country road. If several detours of from five to ten miles each in the interval between Fremont and the Indiana line are properly ironed out by the new year, as it appeared they would certainly be, this will be the best route between New York and Chicago for 1922, as regards road conditions alone.

Returning to the subject of highway markings, a word may be said about the necessity for a fixed system. There is not much satisfaction in realizing, after driving three or four miles, that the markers have ceased and that one must go back for the turn that was missed. A single pole at a street corner, a fork or a crossroads means anything and therefore nothing. "Straight Through" may be indicated by poles on diagonally opposite corners, and "Turn" by poles set squarely opposite one another in such a fashion that one *must* turn to pass between them. This procedure is open to two criticisms, however: the strange driver approaching on the side road may be misled by the "Straight Through" arrangement to suppose that he is on the highway; and since the route runs in both directions, signs on three out of four corners are necessary to indicate completely a turn. Better, I think, is the plan of putting a marked pole on the corner, and another a few yards beyond, on the straight-ahead road or around the corner, as the case may be. The driver then quickly forms the habit of never passing a possible turn until he has located the second pole. The sign on the first pole may usually be so attached that its arrow gives the eye a very strong suggestion of the direction in which to seek for the second one. This I find to be the chief value of the arrow; as actual instructions for the steering hand it doesn't amount to much. But I should like to follow a previous mention of the subject with the following query, for the ears chiefly of Ohio road authorities: When two divergent roads each purport to be the Lincoln Highway, what is the motorist from another state to do about it?

As a final word I want to repeat the protest which the SCIENTIFIC AMERICAN has several times voiced against the promiscuous use of danger signs. In Ohio and Indiana I saw curves posted as "sharp" and "dangerous" which were so wide that at any point on them I could see fifty yards or more around them. Coming across New York, hills were posted as "steep" and "dangerous" down which I could coast only with my clutch free—they were not steep enough to overcome the compression if I left the gears in action. Such misuse of warning signs can have no other result than the creation of a contempt for cautions in the mind of the driver—and when he comes to a place where the warning is really in order this is likely to be serious. The originator of the tale of "Wolf! Wolf!" was a psychologist.

From Easel to Cover

(Continued from page 19)

Meanwhile the printing plate must be prepared. It consists of a sheet of rather thin aluminum, the surface of which must be properly grained to receive the transferred image. The graining is done by means of a rocking table, driven by an electric motor. The table carries a large shallow tank in which is placed the aluminum plate, covered with hundreds of marbles and a thin layer of special liquid. The rocking action of the rocking table causes a steady flow of marbles over every portion of the aluminum surface, as shown in our eleventh sketch, with a resultant fine grain finish.

The next step takes us back to the thin sheets of India paper carrying the impressions from the zinc originals. These India paper sheets are now carefully mounted on a heavy sheet of cardboard, by means of little sharp-pointed steel tools. A slight blow with the sharp-pointed tool causes the thin paper to stick to the heavy cardboard. The sheets are mounted with due thought given to the registering of the other companion plates of the same cover illustration. Various pieces of transfer paper can be mounted on the cardboard; in fact, one is surprised to note the ingenious manner in which the men engaged in "sticking up the sheet" can patch various advertisements, covers and other pieces of typography together.

The cardboard "form" being duly prepared, it is placed face down on the aluminum plate, as shown in our twelfth sketch, and passed through a press which exerts a heavy pressure. When sufficient pressure has been applied, the India paper transfer sheets are found to be firmly held on the aluminum sheet. They are carefully removed with the aid of a moistened sponge, as shown in our thirteenth sketch, leaving the inked images on the aluminum. These images are successively etched by means of a sponge moistened with the acid solution, as shown in our fourteenth sketch, and reinked, until a satisfactory mechanical image results.

At this stage of the process we have an aluminum sheet containing the four sets of images for the yellow image, another aluminum sheet containing four sets of images for the red, still another sheet containing the four sets of images for the blue, and a final one containing the four sets of images for the black. These aluminum sheets are now placed on different offset presses and clamped on the cylinders, as shown in our fifteenth sketch. Obviously, the yellow plate receives yellow ink of the proper shade, the red receives red ink, and so on. The "sticking up" of the cardboard form has been done in such a careful manner that the spacing of the various images on all the aluminum sheets are in perfect register when printed on to the same sheet of paper.

The principle of the offset press has already been described, and the essential details may be noted in our sixteenth sketch. The aluminum plate is held on one cylinder, and is inked by a set of ink rollers, and kept moistened by dampening water rollers. The aluminum plate transfers its images on to the rubber blanket, which in turn offsets the images on to the sheets of paper that are steadily fed through the press by automatic mechanism. The offset press is capable of as many as 4,000 to 5,000 impressions per hour, which, in the case of the SCIENTIFIC AMERICAN covers, printed "four up," or four sets of plates at a time, means a color is printed on 16,000 to 20,000 covers each hour. Naturally, four colors require four times the number of impressions.

The offset process is peculiar in that it permits printing on coarse paper as well as highly coated paper. This is not so with the usual press, which must work with smooth paper in reproducing half-tone or color work satisfactorily. The reason for this is that if too light a pressure is applied, only part of the half-tone dots print. If too much pressure is employed, the dot is smashed into the paper with a resulting muddy, heavy appearance. The usual method of overcoming these obvious difficulties with the letterpress is to employ a very coarse half-tone screen, 85 or even 65 lines to the inch. These screens will print more clearly on coarse paper, but naturally the dots are quite prominent and not suitable for high-class work. The offset process gives the user the choice of any paper, ranging from a fine coated paper to a rough antique stock. Incidentally, the best results are obtained with a rough finished paper.

The Planets

Mercury is a morning star all through November, and is best visible on or about the time of his greatest elongation, which occurs on the 16th. At this time he is 10° 27′ west of the sun, and rises more than an hour and a half before sunrise, so that he should be easily visible.

Mars is likewise a morning star, rising between three or four hours earlier than the sun.

Uranus, meanwhile is in Aquarius, and visible in the early evening, while Neptune is in Cancer, and observable in the morning.

Venus is still a morning star. She rises about two hours, or a little more, before the sun, and is more conspicuous than any other planet for those observers who will follow her example.

In the middle of the month all the five planets known to the ancients will be simultaneously visible in the morning sky, and fairly close together—an unusual occurrence.

Jupiter and Saturn are morning stars like the others, and are close to Mars. On the 13th Mars and Saturn are in conjunction, the former being 53′ to the southward, while on the 26th Mars and Jupiter are still closer, only a sixth of a degree apart.

The moon is in her first quarter at 11 A. M. on the 7th, full at 9 A. M. on the 15th, in her last quarter at 7 A. M. on the 22nd, and new at 8 A. M. on the 29th. During the month she passes near Saturn on the 24th, Mars and Jupiter on the 25th, Venus on the 27th, and Mercury on the following day.


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